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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Telephone: Central 1885. Telegrams: CIRA.

The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*).

Forthcoming Events.

OCTOBER 9.

Institute of Metals:—Scottish Local Section. Display and demonstration at the Royal Technical College, arranged by Prof. Robert Hay, B.Sc., Ph.D., Chairman.

OCTOBER 10.

Institute of Metals:—Meeting at Swansea. Address by A. G. Ramsay, B.Sc., Ph.D., Chairman.

Institute of Metals:—North-East Coast Local Section. Exhibition of films.

Sheffield Metallurgical Association:—"Properties of Austenitic Steels," Paper by Dr. L. B. Pfeil.

OCTOBER 12.

Manchester Association of Engineers (Students' Section):—Chairman's address: Frank Walker, M.I.E.E.

OCTOBER 13.

Institute of Metals:—Sheffield Local Section. "Centrifugal Casting of Non-Ferrous Alloys." Paper by F. W. Rowe, B.Sc.

Institute of British Foundrymen.

OCTOBER 6.

Birmingham, Coventry and West Midlands Branch:—Presidential address by E. J. Lewis.

OCTOBER 7.

Lancashire Branch:—Meeting at Manchester, at 4 p.m. Presidential address by Mr. Arthur Phillips, followed by lecture "The Manufacture of the Mammoth Cunard Castings," by Mr. F. Swift.

OCTOBER 10.

Burnley Section:—"Foundry Essentials and Incidentals." Paper by Mr. F. Whitehouse.

Sea-Water Corrosion.—I.

The problem of the corrosion of cast iron crops up so frequently in foundry circles where special service conditions have to be considered that we are apt to overlook the fact that cast iron is one of the best of the various materials for resisting corrosion. Excluding the corrosion-resisting steels, we could probably say that it is the best. This is shown in an extremely interesting way in the various reports on the deterioration of structures in sea water. The reports are Government publications, but the committee which supervises the work is one of the Institution of Civil Engineers, and its work has been mainly directed towards the corrosion of irons and steels, timbers, and concretes, such as are used for dock and harbour construction.

The various materials tested included wrought irons, Swedish charcoal irons, and Armco iron, various carbon steels, special steels containing copper, nickel, and a rust-resisting chromium steel, and two cast irons—cold blast and hot blast. Provision was made for a complete range of mechanical tests, analyses, and microscopic examinations, and arrangements were made for testing the samples from various parts of the world under a variety of conditions with respect to corrosion.

The work began in 1916, and the last report that was published in March, 1933, is the thirteenth. This will give some idea of the scope of the work and the volume of material collected. Pressure on our space prevents anything like a full treatment. Not only do the reports contain sections written by overseas engineers who were given charge of the various samples, but the opinion of a wide circle of authorities and public bodies was sought, and abstracts of similar work abroad are added.

The eighth report published in 1927 gives details of exposure of specimens at Halifax, Nova Scotia, for a period of five years, and in this report the analyses are given. The results of atmospheric tests, alternate wet and dry, and complete immersion conditions, place both the cast irons first in order of merit in every case. The series exposed at Auckland, New Zealand, gives somewhat similar results, the cast irons being second only to very high-nickel or high-chromium steels. For want of space we pass over the results of specimens exposed at Plymouth and Colombo, and proceed to the last report, which contains Dr. Newton-Friend's final examination of a series of specimens exposed at Halifax for ten years. The results of atmospheric corrosion are such that, apart from one high-nickel steel, the relative corrosion of the two irons are less than that of any other ferrous material tested, the wrought irons, Swedish irons, and Armco being about twenty times as liable to corrosion. The condition of the cast irons was said to be excellent, and fracture showed no internal corrosion. For alternate wet and dry conditions the story is very similar, and for complete immersion the cast irons were better than all the other materials except a 36 per cent. nickel and a 13 per cent. chromium steel. We hope to deal with the slight, but interesting, difference between the hot-blast and cold-blast irons at a later date.

An Excellent Example.

When the visitors to the Czecho-Slovakian Foundry Congress learnt from the daily Press that during the meeting of the Iron and Steel Institute in Sheffield, Sir Robert Hadfield, Bart., F.R.S., D.Sc., had given a sum of £5,000 to the Metallurgical Department of Sheffield University, there was much discussion as to whether it would be ear-marked for financing the new courses in foundry practice, which are to carry with them academic degrees. Thus, on returning home, we called on Sir Robert to offer our congratulations and to ascertain his views as to how the money should be spent. Sir Robert made it quite plain that he had imposed no restrictions, but had suggested to Prof. Andrews that he would like at least some of the money to be credited to the new foundry department. His great wish was to see similar support being accorded by the grey-iron, malleable and non-ferrous sections of the foundry industry. If but one industrialist from the light-castings, the stove grate, the textile, the automobile, the shipbuilding, the brass and bronze, the light alloy, the railways, the roll makers, the pipe makers, and the heavy and the electrical engineering foundries would make similar donations this would give £60,000, which would enable the new department to be self-supporting for ever.

The trained foundry specialist is an essential if the results of research carried out by the British Cast Iron Research Association and

similar organisations are to be intelligently applied within the industry. At the moment, research organisations have not only the duty of instituting research, but have also to create a development department to help industry to apply their results practically. As soon as sufficient specialists are created by the new department this second activity should no longer be necessary, except, perhaps, for the smallest concerns.

Sir Robert has given the industry a splendid lead, which must be emulated by many others if the industry is to keep abreast of the latest scientific developments.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Standardised Sand Testing.

To the Editor of The Foundry Trade Journal.

Sir,—I have read with interest the replies of the Sands Sub-Committee to the Sand Testing Report.

It is encouraging to feel that there is now a standard agreed to, upon which British investigators can build results which will be comparative one to another.

With reference to the permeability of sieved samples of sand, the contrary findings of Mr. Ridsdale to my own experience is understandable in the light of some further investigations I have made on this very interesting problem, the results of which are given below.

Red Sand.—Milled 3 min. in light-roli mill. Divided into three parts. Each part put through the appropriate sieve only.

	Permeability.	Strength. lbs. sq. in.
Average of three tests as milled	23.32	6.72
Through 8-mesh sieve ...	28.9	5.2
Through 16-mesh sieve ...	30.46	4.8
Through 30-mesh sieve ...	28	6.9

Facing Sand.—70 per cent. black sand, 25 per cent. red sand, 5 per cent. coal dust, milled 5 min.

	Permeability.	Strength. lbs. sq. in.
Average of three tests as milled	21	4.8
Through 8-mesh sieve ...	26	4.5
Through 16-mesh sieve ...	27.3	3.9
Through 30-mesh sieve ...	20.1	4.7

Not possessing a 12- and 20-mesh sieve used by Mr. Ridsdale, I could not include them in the tests.

From the results it appears that between 16 mesh and 20 mesh (Mr. Ridsdale's result) there is a mesh where maximum permeability is reached, with finer meshes than this the permeability is reduced and the strength increased.

The cause of this is not very clear; the phenomenon seems more marked in facing sands than raw sands, and the optimum mesh probably varies with the grain size of the sand.

As to the 20 to 40 permeabilities referred to by Mr. Ridsdale in his reply were quoted from memory in the discussion. If reference is made to my Paper, published in The Foundry Trade Journal, June 22, 1933, it will be seen that the largest difference recorded is from 28 to 40 obtained by progressive sieving the sand from "as milled" to 16 mesh through 2, 4, and 8 meshes.—Yours, etc.,

John Hird,
c/o John Williams (Cardiff), Limited,
East Moors, Cardiff.
October 2, 1933.

District Presidents.—No. 8.

INSTITUTE OF BRITISH FOUNDRYMEN, SHEFFIELD BRANCH.

Mr. William Taylor Kitching was educated at Oundle School, Northants, and upon leaving school became a pupil with the Horsehay Company, of Horsehay, Shropshire. He left Horsehay for America and joined the staff of the Eastern Steel Company, Pennsylvania, where he obtained considerable experience in rolling-mill and open-hearth furnace operation, design and management. He then went to the Federal Furnace Company of South Chicago as engineer and assistant master mechanic. Here he was particularly interested in the design and operation of blast furnaces, and had experience in coke qualities and coke-oven operation at Lebanon P.A. and the Bye-Product Coke Corporation of South Chicago.

Mr. W. T. Kitching.

Mr. Kitching returned to this country in 1915 and received a commission in the Royal Engineers. He was demobilised in 1919 with the rank of Major, and joined the staff of Messrs. Steel, Peech & Tozer as works engineer, where he was responsible for the installation and maintenance of the rolling mills at both Templeboro' and the United Strip & Bar Mills.

Mr. Kitching then became managing director of Messrs. John Fowler (Don Foundry), Limited, makers of chilled and grain rolls and special castings. It is interesting to note that the late Mr. John Fowler, who died in 1928 at the age of 90, made the first ingot mould into which Bessemer poured his steel. In 1932 Mr. Kitching was appointed general manager of the ironworks of Messrs. Newton Chambers & Company, Limited.

More about Wilkinson.—In the current issue of "La Fonte" (No. 9) Mr. Montard continues his story of the evolution of the Indret Dock Yard foundries. Little light, however, is thrown on the personality of this prominent Englishman.

Aluminium alloys can be prevented from sticking to metal moulds by painting them with the following solution:—One part colloidal graphite suspended in water and ten parts of water to which is added 6 per cent. silicate of soda.

The wear on the interior surfaces of core boxes to be used with blowing machines can be greatly reduced by chromium plating them. This will reduce the wear due to the abrasion of the sand, and also facilitate the removal of the finished core from the box.

Random Shots.

I offer for your delectation this week a batch of unusual correspondence culled from the "Martin-Burn House Magazine" with the original comments retained. As the Martin-Burn combine is an Indian concern, I trust and hope that most of the correspondence, or at least some of it, is genuine.

* * *

One of their tea garden managers presented the local postmaster with a clutch of English eggs and a hen: and received this reply.

"Ref. = hen, I beg to state that one of my hens will finish laying egg within a day or two, I wish to put your egg under that hen. As we are generally any hen will not sit on any egg, suppose if I keep your hen which you have sent to-day on the egg by covering lid, will she sit again or we shall have to put on? Is the hen in the habit of sitting down on any egg? Please let me know which process I shall have to take."

* * *

How to run the railways at a profit.

Sir,

I beg most respectfully to lay before you the following for your favourable consideration. Without any cost or reward I remove all sorts of intangible dead body of men, dogs and cats etc. and other rubbishes which fall accidentally on your Railway from —— station to ——. All station masters are known about my work. For my reward, I pray to you that you will allow me to travel on your railway without ticket or fare and please let me have a pass-ticket.

Fervently hoping that my prayer will be granted.

I have the honour to be
Sir
Your most obedient servant.

* * *

To The Traffical Manager
Howrah Amta, Siakhala, Light Railway.

Sir,

With due respect and humble submission to your honour, I beg most respectfully to offer me a situation of Ticket Collectorship which has fallen vaccant in your office. Since two years I am always in quest of a job but I am quite axausted now.

Regarding my qualification I have read upto the Matric standered. You are a kind-hearted man and please provide my family with a job. You will be kind enough to offer me a situation in your office.

"Axausted" is apparently the *mot juste*: or would axe-ousted be juster?

* * *

A letter to a firm of postcard publishers:

"I am here calling your attention upon this few lines.

"I have posted to you postal order for your fine and suppernatual postcards.

"I wonder that your name and address had been appreciated by any one on account of your good work. So on the receipt of this order kindly forward it to me in time, for I am anxious to deal with hardly. Kindly supply any kind in assorted.

"Commending my words to your serious attention and asking your pardon for my plain speaking. Curtail here with thousand kises to self and circles."

* * *

"In the end I feel fervent that magnanimous-minded and firm-footed goodselves like your principle-minded persons, would encourage me by continuing the commission already granted . . . for which I assure you my honest and strenuous efforts and painstaking ability.

"Nothing more to add than to wait and watch eagerly for your favourable advice which will no doubt throw us in deep ditch of thankfullness, meanwhile,"

Can it be that firm-footed means footed by the firm—*i.e.*, kicked out?

Marksman.

Institute of British Foundrymen.

LONDON BRANCH.

A MODERN AUSTRALIAN FOUNDRY.

The London Branch of the Institute held the first meeting of its new session on Wednesday, September 6, at the Charing Cross Hotel, London, W.C.2. There was a large attendance of members and visitors, to hear Mr. C. H. Kain, the Branch-President, deliver his Presidential Address, and to hear a Paper read by Mr. R. G. Russell, of the Russell Manufacturing Company, Melbourne, Australia, describing his foundry, which specialises in the manfacture of castings for automobiles. The Paper, which was published in our issue of September 7, was illustrated by an excellent cinematograph film showing the various processes in the foundry, which film was described by most of the speakers as one of the best and clearest industrial films they had seen.

THE SINGLE-CAST PISTON-RING FOUNDRY OF MESSRS. RUSSELL MANUFACTURING COMPANY, MELBOURNE, AUSTRALIA.

PRESIDENTIAL ADDRESS.

By C. H. KAIN.

Presidential addresses frequently fall into one of two classes. Firstly, those reviewing the Institute and its membership, and, secondly, those dealing with some aspect of foundry practice in which the speaker is an expert or an enthusiast. Apparently the first should properly be the province of the secretary and executive council, because it is really a form of propaganda and is actually economic in its inspiration, since it seeks to sell membership of the Institute, the position being similar to that of the eighteenth-century "Man of Business." The second class ought to be read in the form of an ordinary Paper open to full and free discussion, since it is impossible that everyone can agree with the speaker on very highly-controversial subjects.

If one pauses to consider the real function of the presidential office, it will surely be concluded that it is to act as guide, philosopher and friend to the body. Therefore, the President should guide the policy and principles of the Institute rather than concern himself with commercial or technical detail, however important.

Philosophers, such as Machiavelli and Francis Bacon, have laid it down that "purpose decides policy." What, then, is our purpose? The motto of the Institute enunciates that it is to combine the principles of science with the effort of labour. The ultimate aim is a highly developed and efficient industry which shall form an integral and valuable part of our civilisation.

Sir W. Flinders-Petrie, the Egyptologist and archæologist, has shown that all Mediterranean and European civilisations have followed the same definite order in the exploitation, highest expression and developments of the arts and crafts. The order is:—Sculpture, painting, literature, music, the development of mechanics, the use of science, and the exploitation of wealth. Each of these arts attains a point of highest inspiration and development which is followed by a long period of decline. It is not for us to question or debate these findings, but as the present time coincides with the last few stages on the curve, we must ask ourselves if there is any tendency for Institutes such as ours to pass through the last three phases of Flinders-Petrie, namely, mechanics, science and wealth.

It cannot be denied that all the present technical institutions have their original inspiration in the mediæval craft guilds, and their immediate roots in the highly-skilled trades union and their concomitants, the mechanics' institutes of the nineteenth century. During the first 25 years of the present century the sciences have been intensively developed industrially and applied to productive processes, largely through institutes such as ours. And latterly a tendency has arisen to devote a large portion of the time available to economic subjects. If Flinders-Petrie is right, we are faced with slow decline at the best, and complete collapse at the worst! What, then, is the remedy? In four words, "Quality rather than quantity."

Is it not strange that in a period of wealth and luxury such as the world has never known the prevailing cry should be, "Cheap, cheaper, cheapest"? And would not members be rendering the greatest service to the Institute, to the industry, and to the world at large in constantly seeking to improve the quality of foundry products?

Technicians are continually making available new and better materials, so that to-day it is almost unheard of for any of us to fail to meet a strength specification. The older members of the Institute, after many years' labour, have perfected an educational scheme to ensure the quality of future recruits to the industry. What, then, must the ordinary members of the Institute seek to do?

It is apparent to all that amongst bought scrap there is the high percentage of unsound castings, some of which have stood up to active service for many years. No one dare mention their own foundry wasters or the defects disclosed in their customers' machine shops. Do members ever study the insurance companies' or the Admiralty's reports on failures? If so they must realise that the greatest field open is the production of sound castings, not only because quality and excellence is a desirable end in itself, but because quality in this case pays handsome dividends. Consider the position if a founder knew every casting he turned out to be sound. Think what he could do to the competition which so worries him now!

The Iron and Steel Institute, in forming its Ingot and Steel Castings Committees, has recognised that this question of soundness is one of the most pressing matters before the metallurgical industries to-day. And the admirable secretary, Mr. Lockwood, has had this in mind in arranging the programme for the present session. At the last meeting it was proposed to hold a Short Paper Competition, and it is suggested that it should be considered as a small symposium on "Soundness." The Papers will be read anonymously, and should not be of more than ten to fifteen minutes' duration. It would be of very great assistance if they could be submitted to the Secretary before January 1.

More discussion at the meetings is essential. Nothing is more discouraging to a lecturer than to be received in stony silence. All know a little on all foundry topics, and questions or discussion, even if they only bear indirectly on the subject of the Paper, often form the most valuable part of a meeting. Boswell, in his "Life of Johnson," said: "Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it." If a member does not possess the first kind of knowledge let him learn to avail himself of the second.

Vote of Thanks.

On the motion of MR. V. C. FAULKNER (Past-President of the Institute), a hearty vote of thanks was accorded Mr. Kain for his address. MR. R. G. RUSSELL then read his Paper on "A Modern Australian Foundry."

DISCUSSION.

MR. J. A. SMEETON, in expressing congratulations, both upon the excellence of the Paper and of the cinematograph film by which the foundry organisation was illustrated, said it was difficult to believe that Mr. Russell was an amateur either in photography, moulding or metallurgy. It was equally difficult to understand how it was possible for a man who claimed that he had not had an intense metallurgical or foundry training to have built up such an excellent and comprehensive organisation as that at Melbourne for the quantity production of probably two or three of the most difficult motor-car details a man could handle. The foundry appeared to be modern in every possible phase; the machine shops contained the latest types of machinery, and the products appeared to be excellent in every way. The difficulty Mr. Russell must have experienced in supplying so variable a market, producing simple cast piston rings and pistons of every possible type for all world makes of car, appeared to be overwhelming. In this

country, where there were large numbers of a few different makes of cars in use, the problem was probably easier, though apparently it had not been met to the extent it could, or should, be. Mr. Russell was to be congratulated heartily upon the success of his endeavours during the past ten years, and it was to be hoped that he would extend his production in the future in other directions.

Centrifugal Castings.

Mr. T. R. Twigger, who is connected with a firm in this country interested particularly in the manufacture of cast-iron piston rings and cast-iron pistons, said his firm was principally concerned with the production of piston rings made from castings produced by the centrifugal process, and that process was used almost universally in this country for such manufacture, except by one particular company. They had had considerable experience of piston-ring production from individual castings, having made many thousands of single-cast rings, and perhaps, under certain circumstances, that method of production might be desirable, but it did not appear to be the best method economically, having regard to the multiplicity of sizes encountered in this country, quite apart from the fact that, in his opinion, certain metallurgical considerations favoured centrifugal casting. One reason was that, as Mr. Russell had shown, usually the silicon content needed to be distinctly high, and it was a matter of some doubt whether this was satisfactory from the metallurgical point of view.

With regard to cast-iron pistons, he gathered from Mr. Russell that the piston castings were treated at 800 deg. C. for two hours. That temperature, however, would be considered much too high, for it would break down most of the combined carbon into ferrite and graphite. He suggested that perhaps the temperature was 800 deg. F.; there would be no possible objection to that, and, indeed, there was everything to be said for such a treatment being given to the rough machined pistons for the removal of casting and machining stresses. He congratulated Mr. Russell on the excellence of the film which illustrated his foundry operations.

Mr. H. J. Young also congratulated Mr. Russell upon his Paper and very excellent film. He would ask whether Mr. Russell cast solid the bosses of his cast-iron pistons or whether he cored them out. As regards Mr. Russell's statement that the ferro-static pressure at the bottom of single-cast piston-ring moulds made no difference to the rings he would like Mr. Russell to explain this in greater detail. He had understood Mr. Russell to say that the silicon-content of his single-cast rings was 3.6 per cent. and would he confirm it. He noted with regret that Mr. Russell gave no micro-photographs and no tensile, EN value and such like properties of single-cast piston rings, because he suggested such data would be a more than convincing reply to the remarks of the previous speaker. In conclusion he had found it very intriguing to hear how a process worked by his firm, Hepworth & Grandage, Limited, in Bradford, was carried out by Mr. Russell in Australia.

Mr. F. K. Neath asked if the Brinell hardness figures given were for aluminium or cast-iron pistons. One appreciated, he said, that the annealing of cast-iron pistons for two hours at 800 deg. C. was a softening treatment, but he could hardly conceive that the Brinell figure of 125 which had been mentioned related to the cast iron, because that would indicate that the iron was very soft indeed. If the Brinell hardness figure for the cast iron were as low as that the resistance to wear would be very poor.

The Hon. J. M. W. North commented, amid laughter, that after hearing the Paper read and seeing the film exhibited, one would welcome an opportunity to inspect the actual foundry and machine shop. Mr. North also asked for information as to the analysis and the coefficient of expansion of the aluminium used for the pistons.

Mr. W. Tait, referring to the statement that in the production of the single-cast piston rings the boxes were threaded on to pins fitted into a cast and machined plate, asked whether the pins were loose or whether they were fixed and cast in position.

Author's Reply.

Mr. Russell, commenting on Mr. Twigger's reference to the multiplicity of sizes of pistons and rings, remarked jocularly that it was his habit to dodge the production of the troublesome sizes and to buy them from England. With regard to the annealing temperature of the cast-iron pistons, he said that undoubtedly the figure given was too high. The error had slipped his notice.

The problem raised by Mr. Young with regard to coring out the bosses of the solid pistons had constituted one of the greatest troubles experienced. At first the bosses were made solid, but porosity occurred in the bosses; when they were cored out, the porosity was driven down under the ring grooves. He was coming to the conclusion that there was no metallurgical means of overcoming porosity unless one reverted to chilling.

With regard to ferro-static pressure, certainly there was more pressure on the bottom rings than on those at the top, but they froze so quickly that there was no difference between the rings at the top and at the bottom; examination did not reveal any difference. He was unable to give Mr. Young the information he had asked for concerning the tensile and other properties of the single-cast pistons, because when he had left Melbourne he was unaware that he was to read the Paper, and, therefore, had not armed himself with detailed information.

The Brinell hardness figure of 125, referred to by Mr. Neath, related to the alloy pistons; the Brinell figure for those pistons as cast was 107, but after ageing treatment it was from 125 to 130. Commenting on Mr. North's remarks, he said he would welcome a visit from any members of the Institute who might have an opportunity of going to Melbourne.

The aluminium pistons contained 9 to 11 per cent. copper, 1.25 per cent. silicon and 0.35 per cent. magnesium. The analysis was practically standard in America. Dealing with Mr. Tait's question, in regard to piston-ring production, concerning the threading of the moulds on pins, Mr. Russell said that the pins were tapered on the ends and the holes were reamer tapered in the bottom plate. The pins were put into the holes and the men stacked the moulds on the pins; when the top was put in, they withdrew the pins. Each packer had a stock of pins.

A Vote of Thanks.

Dr. A. B. Everest, proposing a hearty vote of thanks to Mr. Russell for his Paper and his film, reminded the meeting that when he had left Australia he had had no intention of reading a Paper, so that he had not brought with him the detailed information he would have brought otherwise; the gratitude of the members of the Branch, therefore, must be all the greater. The material of the Paper, and the photographic quality of the film, were excellent. Dr. Everest added that never before had he seen a film in which molten iron really looked like molten iron and molten aluminium looked like molten aluminium.

Mr. W. O'Keefe, on rising to second the vote of thanks, explained he was granted this privilege owing to the fact he was a fellow-countryman of the speaker, but he himself had been associated with the British foundrymen of Great Britain for many years. It was interesting to the foundrymen of this country to learn the progress that was being made in the outposts of the Empire, and Mr. Russell's Paper, dealing with his excellent plant in his foundry at Melbourne, and the interesting film shown, which concentrated attention on the salient points, was quite the best works film he had ever seen. It proved that they were very progressive in Mr. Russell's foundry. He assured Mr. Russell of a warm welcome in this country, and no doubt he had already met many interesting foundrymen over here, which gave him assurance of the hearty welcome.

The vote of thanks was carried with acclamation.

Mr. Russell, in his response, expressed his gratitude for the warmth of the reception accorded him not only at this meeting, but also at the various works he had visited in this country and on the Continent. If Australians did not visit Europe occasionally, he said, they became stale, and one of the reasons for his trip was to gain new ideas.

The Short Papers Competition.

Discussion was invited by the President upon the proposed Short Papers Competition which it was hoped to arrange at the end of the session.

In reply to a question as to whether prizes would be offered, he said that the London Branch would adopt the policy of other Branches which had held such competitions. On being informed that it was the practice in other Branches to offer prizes, he said that that could quite well be arranged.

Replying to a question as to the subject of the Papers to be submitted, he said he had suggested that they should deal with soundness in castings, because, after all, one of the greatest difficulties of the foundryman was to produce sound castings. However, it was proposed that the subject should remain open. The Papers would be read anonymously, and the result of the competition would depend on the votes of the meeting.

Notes from I.B.F. Branches.

West Yorkshire. — The new winter-session programme of this Branch of the Institute of British Foundrymen promises to be interesting. Opening on October 14, at Bradford Technical College, there is to be a visit of inspection, during the afternoon, of the new and important extensions of the College, the formal opening of which is on the previous Saturday, October 7, by the Earl of Athlone, K.G., Chancellor of the University of London, so that the foundrymen will be among the earliest visitors to the extensions, the inauguration of which coincides with the jubilee celebrations of the College. The original College was opened by the late King Edward, when Prince of Wales.

After tea on the opening day of the session—as guests of the President (Mr. R. D. Welford)—the members will hear Mr. Welford's Presidential Address; following which, Mr. G. Copeman, of Leeds, is to open a discussion on "Foundry Problems from a Patternmaker's Viewpoint."

A works visit is being arranged for the members on November 11, but details are not at the moment of writing available. On December 9 Mr. F. E. Steele, of Sheffield, is to lecture on "The Progress of Machine-Moulding Practice." The New Year opens with the Branch annual dinner on January 13, an occasion established three years ago and now thoroughly well established as an eagerly-awaited festivity. On February 10 the members will visit the works of Messrs. W. C. Holmes & Company, Limited, of Huddersfield, one of the most interesting engineering undertakings in Yorkshire. Mr. E. Longden, of Manchester, is to address the members on March 10 on the important problem of "Porosity," and the final technical evening is April 14, when Mr. F. Whitehouse, of Sheffield, is to speak on the all-important subject of "Foundry Costs." The annual general meeting and election of officers brings the session to a close on April 28. It is gratifying to note that the technical-reference library of the Branch grows steadily.

Works of the Park Gate Iron & Steel Company, Limited.

VISITED BY MEMBERS OF THE IRON AND STEEL INSTITUTE.

Among the works visited by members of the Iron and Steel Institute in connection with the autumn meeting at Sheffield, were those of the Park Gate Iron & Steel Company, Limited, These works were founded in 1823, and were originally engaged in the production of pig-iron and the manufacture of puddled iron. Many events of interest occurred during the period up to the introduction of steel manufacture. The whole of the plates for the "Great Eastern" were made at the Park Gate Works in 1854, and it is interesting to record that when this ship was broken up some of the material was adapted for the construction of a well-known blast-furnace plant in the Midlands, and is, as a matter of fact, still in use.

The Park Gate plate mill was the first reversing mill in this country, and thus solved the problem of more easily handling heavier masses of material. In 1856 armour plates were supplied 3 in. to 4½ in. in thickness for H.M.S. "Terror" and during the ensuing nine years for H.M.S. "Zealous" and "Achilles" and a number of other vessels.

The first trials for the production of pig-iron from Frodingham ore were made in one of the Park Gate blast furnaces, and later developments led to the acquisition of large iron-ore properties in that district. The company now owns areas in Lincolnshire, Northamptonshire and Leicestershire, which assure an adequate supply of ore for the next 50 or 60 years.

The development of steel manufacture by the Bessemer process, and later by the open-hearth process, marked an epoch in the history of the company. The first Bessemer ingots made in Sheffield were sent to Park Gate to be rolled. After close investigation into the merits of each process, it was decided to adopt open-hearth furnaces for steel production. The two first units were built in 1888. They were each of 25 tons capacity and entirely hand operated. Ten years later electric power was applied to the works, and this enabled Wellman electric charging machines to be installed for the open-hearth furnaces. These were among the first

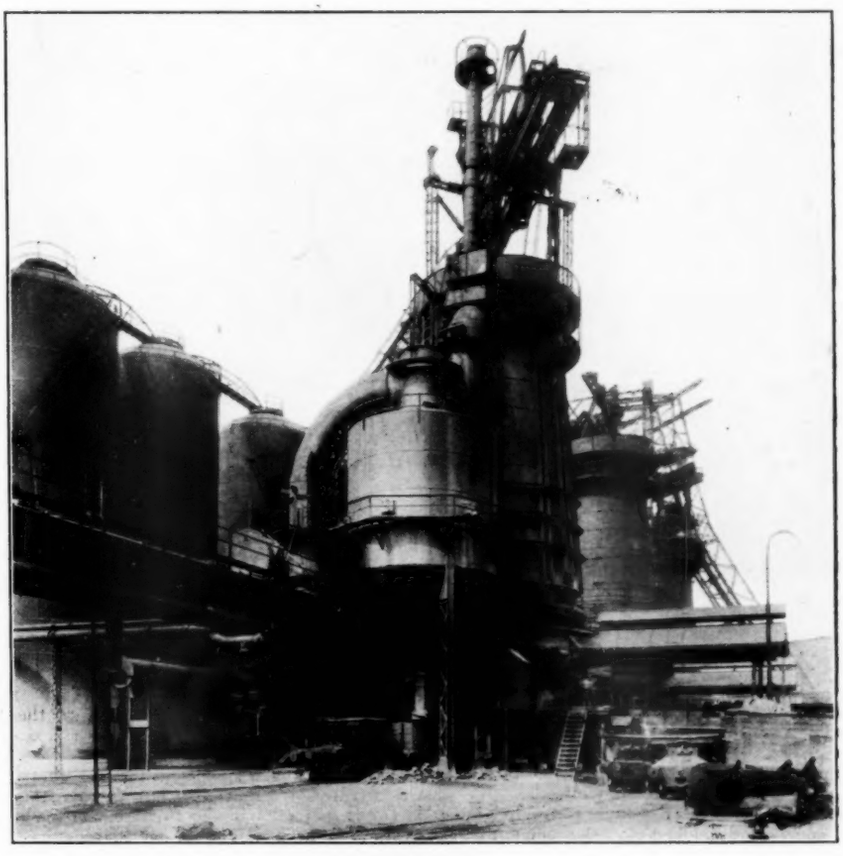


Fig. 1.—View of Blast-Furnace Plant of the Park Gate Iron & Steel Company, Limited.

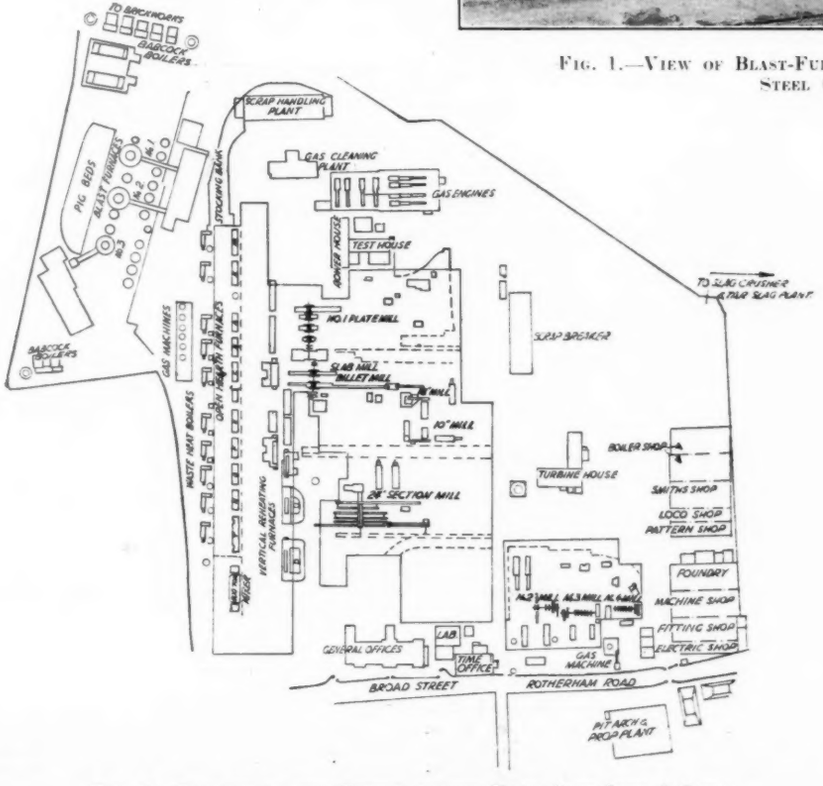


Fig. 2.—Lay-out of the Works of the Park Gate Iron & Steel Company, Limited.

mechanically-operated chargers to be introduced into Great Britain, and they represented a great advance in the development of labour-saving machinery.

In 1908 it was decided to discontinue the manufacture of puddled iron, and subsequently the works were entirely devoted to the production of pig-iron and the manufacture of steel. Progress and developments have since been continuous. The old plant has been gradually eliminated, and in its place machinery introduced specially designed to meet requirements, until to-day the organisation and equipment available for the service of the users of Park Gate products is unsurpassed.

Blast-Furnace Plant.

The blast-furnace plant consists of three units equipped with mechanical charging and distributing gear. The raw materials used in the production of the pig-iron are all mined in this country, and the operation of the plant is at once efficient and economical. The air blast for blowing the furnaces is supplied by means of blowing engines driven by a portion of the gas generated in the furnaces. The blast-furnace gas, which in earlier days was emitted to atmosphere, is now entirely utilised. A proportion is, of course, needed for the service of the stoves and the remainder is burned under large Babcock water-tube boilers in which is generated the steam for the works service. In this way, the use of coal for steam-raising has been practically eliminated. In order to take care of exceptional periods, however, some of the boilers are equipped with

a coal-pulverising machine which enables powdered coal to be burnt along with the gas. The combustion of powdered coal is very similar to that of oil, and the auxiliary fuel can be brought into service or taken out again in less than two minutes.

Some time ago the Ford Motor Company, of Detroit, U.S.A., claimed that the application of both blast-furnace gas and powdered coal to boilers was first used at their works. As a matter of fact experiments were made and the details of the procedure worked out and applied at Park Gate at least two years prior to a similar practice being adopted at Detroit.

Fig. 3.—Charging 60-Ton Open-Hearth Furnace at the Works of the Park Gate Iron & Steel Company, Limited.

The blast-furnace slag, which is treated by a special process developed by the company, is taken to a separate plant where it is crushed, graded and ultimately tarred for road-making. A new plant has recently been put into commission in which the most up-to-date equipment is embodied; indeed, the whole forms one of the finest plants in the country for the utilisation of blast-furnace slag, and is capable of producing 3,000 tons of finished product per week.

The works as a whole naturally use a large amount of coal; however, relatively little is burned in the solid state, the bulk being converted into gas before being used in the various processes. To carry out this conversion a large gas-machine plant has been installed. This consists of six Wood machines, each capable of gasifying 2 tons of coal per hour. The total gasifying capacity is 80,000 tons per annum. The plant is entirely mechanical and, further, is equipped with the latest types of recording pyrometers, pressure gauges and other devices for its scientific control.

Open-Hearth Plant.

The open-hearth plant is served by a 400-ton mixer of the active type, into which is poured the hot metal produced in the blast furnaces and conveyed from thence in large ladles. The mixer acts as a reservoir from which hot metal of a uniform analysis can be drawn for charging the open-hearth furnaces. The range of open-hearth furnaces comprises ten units varying from 80 tons to 50 tons capacity. Steel can be produced by the acid or basic process as required. Here again many devices for the efficient operation of the plant have been applied. Each furnace is equipped with a waste-heat boiler of special design; this provision is directly responsible for a valuable economy in fuel. Several furnaces are fitted with automatic control gear for ensuring the admission of the proper proportion of air to burn the gas entering the furnace. Automatic gear is also applied for the adjustment of the damper controlling the exhaust gases. The pressure in the hearth of the furnace is maintained at atmospheric level, thus preventing the emission of flame from the door or the inleakage of air. Hence the furnace attendant has only to vary the quantity of gas to what he considers the furnace requires and the automatic gear takes care of the rest of the adjustments.

A charging machine delivers the scrap into the furnaces, whilst the hot metal from the mixer is delivered to the furnace, being charged by a ladle crane. In order to aid the rapid analysis of the steel before tapping, an instrument has been adopted which, by electrical means, gives the carbon content of the sample taken from the bath, and the requisite information is available for the man in charge of the furnace within 4 min. of taking the sample.

The furnaces are tapped by means of a pneumatic tapping gun, which does the work very rapidly; the metal is run into ladles of 60 tons capacity. The weight of the ingots cast varies from 25 to 160 cwts., according to the work for which the steel is required. Feeder heads and other devices for ensuring a sound product are in use. The ingots are re-heated in a battery of seven pits. Particular care is taken to maintain the ingot in an upright position until its arrival at the mill, thus avoiding any disturbance of the interior, which may still be liquid at the time of stripping.

Two overhead charging cranes of the latest type deal with the ingots in the soaking pits and load them on to electrically-driven transfer cars for conveyance to the mills.

Mill Plant.

The major proportion of the ingots are dealt with in either the slabbing mill, which feeds the plate mills, or the billet mill, which serves the section mills. The slabbing mill can roll sizes which range in section from 36 in. by 10 in. as a maximum to 19 in. by 1½ in. as a minimum. The billet mill is capable of rolling blooms to 12 in. square, and any size in cross-section in the range down to 2 in. square. This mill is served by a set of steam hydraulic shears, a 66-in. dia. hot saw which is driven by a 200-h.p. motor, and an electrically-driven billet shears for cutting up the smaller sizes.

The large plate mill is capable of rolling some of the largest plates obtainable in this country. It can roll any width up to a maximum of 11 ft. 9 in. and of any requisite thickness between ½ in. and 2¼ in. Arrangements have recently been made to roll chequer plates of a width greater than anything hitherto obtainable in Great Britain. In this mill the boiler plates, for which the company has long enjoyed a very high reputation, are rolled, as well as material for many other purposes. At the present time the steel required for the construction of two destroyers—H.M.S. "Forester" and H.M.S. "Fury"—is being dealt with in the various mills, as also that required for two sloops recently ordered by the Admiralty.

The three-high plate mill which rolls plates somewhat lighter than those normally produced in the large plate mill is of interest. This equipment enables the plates to be rolled at high speed and along with its re-heating, annealing and plate-handling plant is a good example of the best modern practice. Two further mills are available for rolling still lighter plates and

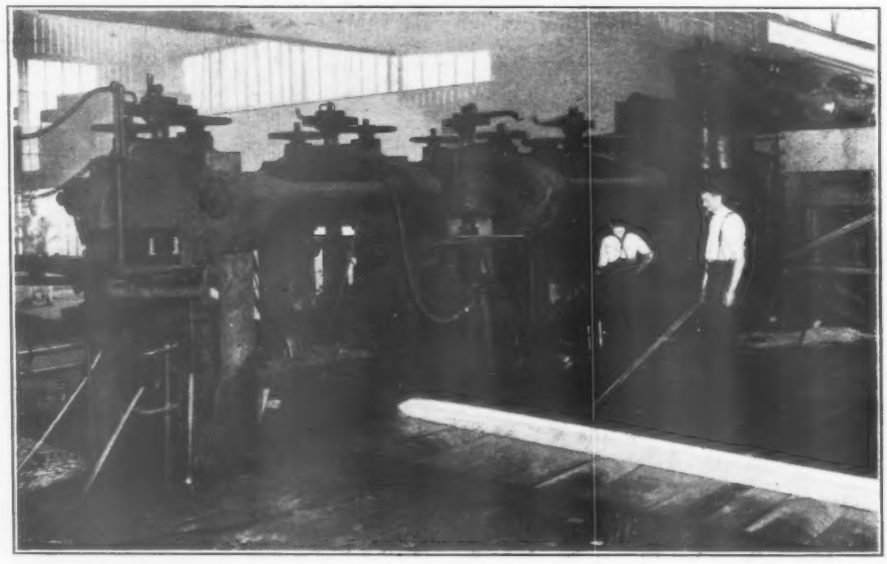


Fig. 4.—View of 24-in. Section Mill, at the Works of the Park Gate Iron & Steel Company, Limited.

sheets; these mills are also equipped with annealing furnaces and straightening machines, so that a high standard of product is obtainable.

An electrically-driven blanking press capable of exerting a pressure of 600 tons forms part of the auxiliary plant to the plate mills. This machine is designed to cut circles out of the solid plate by means of dies, so that the product is a dead true circle exact to the size required. The machine is capable of blanking out discs of various sizes between 8 in. and 30 in. dia., and it has the capacity to deliver 400 blanks per hr. 18 in. dia. Along with this press is a smaller unit designed for punching central holes in blanks. The output of these blanks is approximately 1,000,000 per annum; they are produced for all kinds of purposes, but mainly for pressing work for the motor-car industry.

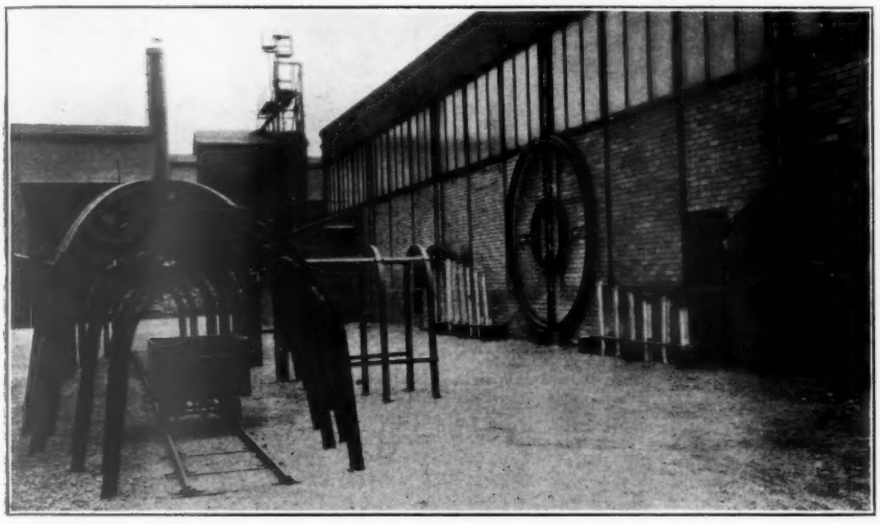


Fig. 5.—Exhibit of Steel Pit Arches and Props, at the Works of the Park Gate Iron & Steel Company, Limited.

The 24-in. section mill in its entirety was designed by the company; it is mainly devoted to the production of joists, channels, angles, etc., and is representative of the very latest practice in this class of work. The mill can be fed with large blooms from the billet mill, after passing through the re-heating furnaces, or it can take an ingot direct from the ingot re-heating furnaces.

The smaller bar mills consist of two units, one with rolls 18 in. dia. and the other with rolls 10 in. dia. Both are electrically driven and are equipped with re-heating furnaces of the latest type. A variety of sections are produced in both units, but in the 10-in. mill bars in round or hexagon form comprise the main proportion of the output. These bars are principally of the special free-cutting quality. The company, it may be noted, were one of the first to make free-cutting steels, and have for many years been producers of this material. Their latest development in this direction, "P.G.F. 4," was placed upon the market two years ago, has found considerable favour and is certainly superior to the similar steels which used to be imported. Its free-cutting properties and uniformity enable it to be machined at very high speeds, whilst giving a perfectly clean and polished surface. The uniformity of such steel is of major importance, because naturally any variation in the free-cutting property causes trouble during the machining process, and in the modern mass-production shop might cause a serious dislocation of output. Another feature is the accuracy to size with which the bar is finished. Park Gate products, always well within the British Standard Specification of 15/1,000ths of an inch, frequently do not exceed 8/1,000ths of an inch.

An interesting development is the increased use of steel for colliery purposes to cope with which a special plant has been installed for the production of pit props and pit arches. The test house and laboratory are in accord with the latest practice, and a research department is available, staffed by expert metallurgists, for dealing with special problems. The works are not only capable of producing all classes of mild steel of the highest quality rolled within fine limits, but are also equipped for dealing with many of the alloy steels, a considerable tonnage of which is dealt with annually. As previously indicated, production can be by either the acid or the basic process, and it is interesting to note that steel to nearly 300 different specifications is produced in the course of the year.

The present weekly capacity of the works is as follows:—Pig-iron, 3,200 tons; steel ingots, 5,000; plates, sheets and bars, 3,600; bricks, 60,000; ground basic slag, 500; tarred slag for roads, 3,000; pit arches, 400; pit props, 100 tons; electric energy, 600,000 units.

The works contain a complete equipment of engineering shops for dealing efficiently with repair work. The generating station is of 5,000 kw. capacity. The company owns 17 locomotives and about 1,000 wagons.

The history of the company is largely coincident with that of the British iron and steel industry. It has taken an active part in many of the technical developments which are essential to industrial progress, and without a doubt it will bear its share in anything the future may hold. The company has admirably adjusted itself to the revised conditions of this new industrial age and, whilst it is able to maintain its position to-day, it is equally ready to participate in that increase in trade which will come with the revival of international confidence.

Nitriding of Steel.—In "Prace Badawcze P.W.U.," J. Fetschenko-Tschopiwski and Wojcik discuss the nitriding of steel with ammonia and the solubility of nitrogen in steel, giving the optimum conditions of nitriding for aluminium and chromium steels. The ageing of nitrided steels is also considered.

Screening Technology.—A. Klein and G. Sippach, of the Carlshütte Foundry & Engineering Works Research Department, have issued a concise but comprehensive "Handbuch der Siebtechnik," dealing with the modern principles of screening and sizing of raw materials. The first part of the book deals with the theoretical side of screening and enters into the various factors which determine the efficiency of screening plant, while in the second part the authors discuss the many different modern types of screening plant, giving details of practical performance and power consumption.

Heterogeneity of Steel Ingots.

SUMMARY.

The Fifth Report on the Heterogeneity of Steel Ingots (Special Report No. 4) was presented for discussion at the autumn meeting of the Iron and Steel Institute.

The present Report is divided into the following sections:—Section I, Introduction; Section II, Ingot Types; Section III, the present position of the analytical determination of non-metallic impurities in steel; Section IV, a further study of steel ingots; Section V, a study of the influence of varying oxygen and carbon content in iron upon the position of blow-holes in steel ingots; Section VI, the equilibrium of the system Fe_3P-FeS; Section VII, estimation of the time of separation of the ingot from the mould.

A certain amount of confusion exists concerning the precise meaning of the various terms descriptive of steel other than fully killed. In Section II, therefore, an attempt has been made to define the terms in common use. It will, of course, be understood that each ingot type merges imperceptibly into the next, and just as no hard-and-fast line differentiates the various ingots, so no hard-and-fast definition can be laid down to describe them. Nor do the Committee aim at establishing such definitions; rather is it their intention to clarify the position by discussing in some detail the various types of ingot, and the various terms commonly employed to describe them.

Section III of the Report contains a discussion of the various methods employed for the separation and determination of the quantity and analysis of the silicate inclusions in steel, and for the determination of the oxygen. It has for a long time been realised that this matter has rested on a not too reliable basis, and now, whilst finality has been by no means reached, certain progress has now been made towards improving the accuracy of the determinations.

In Section IV is described the full examination of three further ingots. The first is a small ingot of high-frequency steel which, whilst possessing no outstanding features, shows the ingot examined to be of uniformly good quality. The second is an ingot of low-carbon steel made by the acid-Bessemer process, and may be compared with example 59, illustrated in the Fourth Report, which was made by the basic-Bessemer process. Finally, the third is an example of ingot iron which, owing to its unique method of manufacture, possesses many interesting features.

Section V is a contribution by two independent investigators, who, working in co-operation with the Committee, have explored on an experimental scale a wide range of compositions with varying oxygen and carbon contents. This investigation also shows clearly the relation of one ingot type to another.

Section VI, also the result of work carried out by independent investigators, is an exploration of the iron-phosphide/iron-sulphide equilibrium, and is of considerable interest in considering the theoretical aspect of the mechanism producing heterogeneity in steel ingots.

Finally, Section VII further extends the mathematical analysis of the cooling of steel ingots to cover the mechanism of the separation of the ingot from the mould.

"Durapid" Surface Annealing Process.—In the "Durapid" process of surface hardening evolved by Budowski & Bardt and described in "Aciers spec.," the material is dipped into a paste prepared from a cementation agent and a catalyst, then heated to a temperature between 880 and 950 deg. for an hour and finally quenched in a special bath. The Paper gives the depth of cementation obtained by heating to a temperature between 850 and 950 deg. for varying periods up to 90 min., and also analyses the comparative cost.

Twenty-Five Years' Progress in Metallurgical Plant.

INAUGURAL LECTURE TO THE INSTITUTE OF METALS.

In the course of his inaugural lecture on "Twenty-Five Years' Progress in Metallurgical Plant," given by Mr. W. R. Barclay, O.B.E. (Vice-President), at the Institute of Metals Silver Jubilee Autumn Meeting at Birmingham, Sir Henry Fowler (President) in the chair, the speaker said that with reference to melting and casting equipment that a detailed description of the various types of furnaces introduced was not possible within the limits of the time available. It was sufficient to point out that it was really the advent of the Ajax-Wyatt low-frequency induction furnace which made the electric melting of brass and copper alloys generally a commercial success, and led to the adoption of electric melting on a wide scale. During the last ten years progress had been exceedingly rapid. In the non-ferrous industries both the arc type and the induction type of electric furnace might be said to be definitely established. The resistance type of furnace had also been developed with considerable success in the melting of aluminium and aluminium alloys. For copper and its chief alloys, induction furnaces of the Ajax-Wyatt and Russ designs were most generally favoured. For higher-temperature metals, such as nickel and its alloys, the Héroult arc type of furnace was most popular. From a technical point of view the most interesting advance was the introduction of the high-frequency induction furnace.

Proceeding, after referring to moulds and casting practice, the speaker, coming to the question of rolling-mill machinery, pointed out that its development, whilst perhaps not so fundamental in nature as that which had occurred in casting equipment, had, nevertheless, been important, and perhaps even more impressive, particularly in the production of sheet and strip metal. Twenty-five years ago the general equipment of practically all non-ferrous rolling mills in this country consisted of what were termed "train rolls," *i.e.*, a series of two-high mills of various sizes driven by one prime mover (steam or electric) and linked up either in series or parallel by reduction gearing. In many cases an entire mill equipment of fifteen to twenty pairs of rolls was driven from one prime mover by the aid of a large and heavy flywheel. Several such mills, driven by the old "Watt type" of beam engine, still remained in this country. Since 1908, and particularly since the outbreak of the war, "train mills" had repeatedly given place to mills individually driven by electric power. The chief advantage of such individually-driven mills was that if a considerable quantity of sheet or strip metal of similar widths and gauges was in demand, such mills could be run independently and continuously without regard to other mills or subsidiary plant.

Modern Individually-Driven Mills.

The modern individually-driven mill, whether of the two-high or the more complex type, was a precision machine, designed and built with all the skill and attention to detail required in a high-grade machine tool. As a consequence, the rolling process had become much more scientific, the percentage of reduction during passes more uniform and regular (with obvious advantages to uniform cold working), and gauging was more accurate, both in cross-section and longitudinally. During the last few years considerable publicity had been given to the more complex individually-driven mills of the four-high and six-high (cluster) type. Such mills should certainly find an important place in any review of rolling development in the industry. In some respects they represented a further improvement even on the precision two-high mill, particularly when, for any reason, metallurgical or economic, appreciable percentage reductions per pass were required. Fortunately, the four-high mill was not introduced into the non-ferrous industry until the two-high mill itself had been vastly improved, both in design and construction.

Regarding cold-rolling mills, a further development was the Steckel mill, which, although not as yet at all widely adopted in the non-ferrous industries, deserved at least a brief mention. This mill was a distinct departure from conventional rolling-mill design, both from an engineering and metallurgical points of view. The fundamental principle of the Steckel mill was the subjecting of strip or sheet metal to cold-working. The strip to be cold-rolled was passed through small working rolls, which had an action corresponding rather to that of dies through which metal was drawn than to that of rolls subjected to pressure. The metal was fed into these working rolls from drums which were electrically driven and capable of rapid reversal. The working rolls of the Steckel mill were exceptionally small (2 in. to 2.5 in. dia.), and had, consequently, to be supported by backing-up rolls. The drive was almost entirely by tension on the strip itself, and the small rolls thus constituted in effect a frictionless rotary die. It is claimed for this mill that by its use considerably greater percentage reductions could be obtained without intermediate annealing than by any other method. The majority of the mills recently erected for the hot-rolling of non-ferrous metals was probably of the three-high type, but several important modern installations, particularly for the hot-rolling of copper and brass, consisted of two-high mills, although these departed somewhat from older designs.

The speaker went on to refer to the Hazelett process, in connection with which, instead of using the normal ingot mould, molten metal was poured between water-cooled rollers in such a way that immediately the metal began to solidify the rollers could be set into operation and the process of reduction to sheet be begun almost instantaneously.

Rod and Wire-drawing Plant.

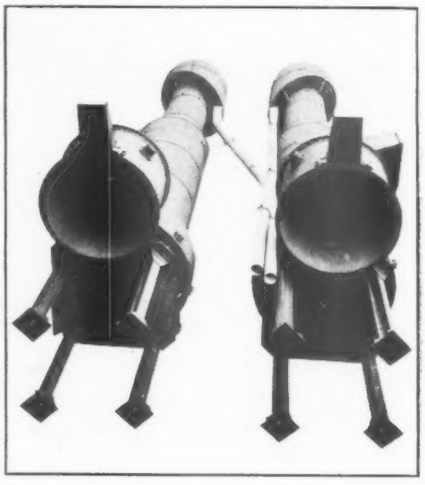
With reference to rod and wire-drawing plant, the speaker said that cold-drawing benches for rods and tubes remained to-day much as they were twenty-five years ago, except for modification in engineering details such as direct electrically-driven worm-gearing. The improvements in rod and tube production during the period had been by no means negligible, but such improvements had resulted from factors other than the process of cold-drawing. The improvements arose mainly from the increased use now being made of extrusion processes. In wire-drawing machinery, however, developments had been very considerable, and were in some degree comparable with those in cold-rolling, particularly in regard to the greater precision and efficiency of modern machines. A movement towards the construction of more efficient annealing furnaces had begun in the period between 1910 and 1915. It was really this movement which started the evolution of the modern annealing furnace. One could scarcely withhold the term revolutionary from the contrasts between the coal- or coke-fired annealing furnaces to be seen in every non-ferrous metal works in the immediate pre-war period and the well-designed and constructed annealing furnaces of to-day. The electric-annealing furnace to-day provided ease of control, uniformity of temperature and cleanliness and general convenience of operation.

Publication Received.

Transactions of the Institution of Chemical Engineers, Vol. 10, 1932.—As usual, the proceedings of this Institution contain a number of Papers dealing with subjects allied to foundry practice, such as electro-deposition, combustion and heat transference.

For the Argentine.

The accompanying illustration is one of a pair of 10-ton-an-hour Rapid Economic cupolas taken from a curious angle. They have been made by George Green & Company, of Keighley, for delivery to one of the Argentine railway companies. They are 50 ft. high and are



An Unusual View of a Pair of 10-ton-an-hour Cupolas.

provided with self-emptying spark arrestors. The contract also includes the supply of electric-charging hoists with tilting skips, specially arranged weigh scale for registering the weight on a tape and motor-driven fans.

Wear in the Polishing of Plated and Other Surfaces.*

By O. F. Hudson.

A series of tests was made in the laboratory of the British Non-Ferrous Metals Research Association to determine the comparative rates of wear of plates and other metal specimens under conditions of polishing as distinct from abrasion. The apparatus used is described, and the results obtained with the following materials are given, using magnesia on wet parchment as the polishing medium: pure platinum, pure palladium, platinum plating on brass, palladium plating ("soft," "hard" and burnished) on brass, nickel plating ("soft" and "hard") on brass, silver plating and brass (60 : 40).

Considered as loss of thickness, the rate of wear of the palladium-plated specimens was found to be greater than that of the platinum-plated specimens, but considered as loss of weight, the wear of the palladium coatings was slightly less than that of the platinum coatings; whilst the precious-metal coatings generally were more resistant than the same metals in massive form. Of the three types of palladium plating, that in the "soft" condition showed the greatest wear, but the differences were not great; there was little difference in the rates of wear of the two kinds of nickel plating. No definite or consistent relationship between hardness and rate of wear in polishing was revealed in these tests.

Aluminium - Chromium Thermocouple. — In "Science," W. C. Stadie and S. L. Wright discuss the requirements of an inexpensive pyrometer for temperature measurements up to 1,000 deg., and recommend an aluminium-chromium thermocouple.

* Abstract of a Paper read before the Birmingham Meeting of the Institute of Metals.

The Sodium-Carbonate Process for Treating Cast Iron.

A NEW DEVELOPMENT.

By E. W. Colbeck, M.A., and N. L. Evans, B.Sc., A.I.C.*

The sodium-carbonate process, which was described by the present authors in the Foundry Trade Journal, Vol. XLIV (1931), pp. 305-307, has since been widely adopted in this country and is also finding application on the Continent, as well as in America. For heavy castings, the method originally described remains unaltered. The powerful agitation induced in the ladle when molten iron is tapped on to sodium carbonate results in a thorough degasification of the metal as well as removing about 50 per cent. of the sulphur and eliminating other objectionable non-metallic inclusions such as oxides and silicates. The result is the production of clean, sound castings which will successfully pass pressure tests, and can be machined with the minimum of trouble.

Fig. 1.—Test-Bar No. 1. Untreated. Unetched. × 200.

Fig. 2.—Test-Bar No. 2. Treated with Mixture. Unetched. × 200.

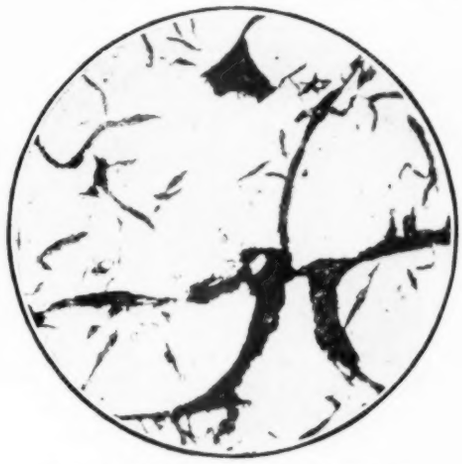


Fig. 3.—Test-Bar No. 3. Untreated. Unetched. × 200.

Manufacturers of light castings, who use small ladles, sometimes find, however, that even the short waiting time required for thickening and removing the soda slag, causes the metal to stiffen too much for running thin, intricate sections. To overcome this difficulty, sodium carbonate has been put on the market in the form of fused blocks which can be added to the cupola with the rest of the charge. This increases the basicity of the slag, so that an appreciable amount of sulphur is removed from the iron, though not so much as can be removed by the ladle method of treatment. Cupola treatment refines the graphite and gives a closer structure to the metal, but in general these effects are not quite so pronounced as they are when the sodium carbonate is put into the ladle.

Treating Small Grey-Iron Castings.

Considerable attention has therefore been devoted to the problem of modifying the ladle method so that it can be used by makers of small grey-iron castings, whose products are frequently required to pass tests quite as rigid as those demanded for heavy castings, such as are used for chemical plant, etc.

The following aims have been kept in view:—(1) To simplify slag thickening and removal; (2) to eliminate the standing time between the end of tapping and the addition of limestone for thickening the slag; and (3) to retain the efficiency of the original method of treatment in the ladle.

It has been found that the first and second of these aims can be readily attained, and the efficiency of the process need suffer only to a slight degree by adopting the following procedure. Instead of putting sodium carbonate alone into the bottom of the ladle before tapping, the requisite quantities of dense sodium carbonate and ground limestone are first intimately mixed together and then put into the ladle and the metal tapped on to the mixture. As a rule, for every hundredweight of metal which is to be tapped, one pound of dense sodium carbonate and ten or twelve ounces of ground limestone will be found to give satisfactory results.

Practical Hints.

Whilst the metal is being tapped on to this mixture, the vivid glare of the sodium flame usually present when sodium carbonate is used alone is diminished to a marked extent. The slag cakes over almost from the start, but it is obvious that it is very active underneath. It is advisable to stir the slag once during the course of the tap, or between taps, if several are required to fill the ladle. This ensures that all the sodium carbonate has an opportunity of reacting with the metal. This stirring should only be on the surface. It is quite unnecessary to stir the slag into the metal.

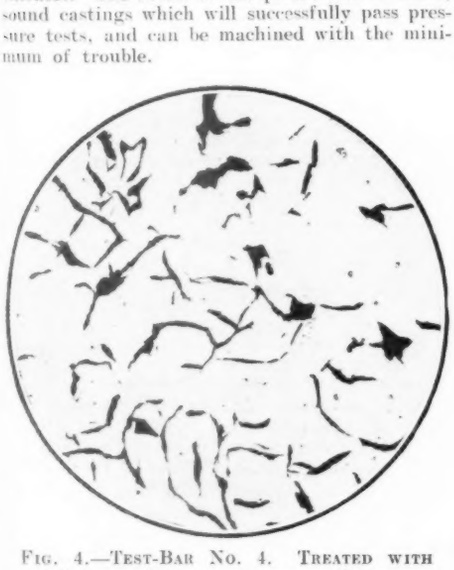


Fig. 4.—Test-Bar No. 4. Treated with Sodium Carbonate alone. Unetched. × 200.

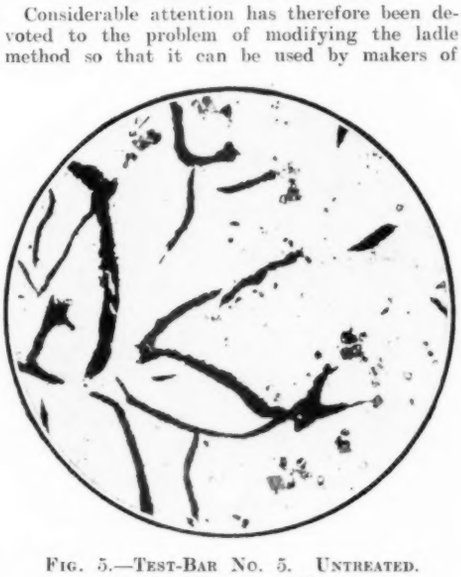


Fig. 5.—Test-Bar No. 5. Untreated. Unetched. × 200.

Fig. 6.—Test-Bar No. 6. Treated with Mixture. Unetched. × 200.

* The authors are associated with the Metallurgical Department, I.C.I. (Alkali), Limited.

Immediately the ladle is full, the slag may be lifted or raked off. This operation is very easy to carry out, even to the removal of the last traces of slag. The metal surface is left perfectly clean, with no liquid slag clinging to the ladle sides. After pouring into the mould, the ladle lining is seen to be practically free from attack around the slag line or at any other level, and the lip keeps free from slag deposits.

The following results were obtained in a series of trials carried out in a foundry where cast-iron pipes are made:—Three ladles of metal were treated—numbers one and three with the mixture of sodium carbonate and ground limestone, and number two with sodium carbonate alone, subsequently thickened by the addition of ground limestone. In each case, samples of metal were taken from the cupola spout, representing untreated metal. About 15 cwts. of metal was tapped each time, so 15 lbs. of sodium carbonate was used. In the case of ladles one and three this was intimately mixed with 11 lbs. of Buxton No. 3 ground limestone. Test-bars were cast in each case, for analysis, metallograph examination and sulphur prints. The results of this examination are set out in Table I.

Table I.—*Experimental Results.*

Test-Bar No.	Description.	Analysis. T.C.	Si.	Mn.	S.	P.	Brinell 10 mm. 3,000 kilos.	Micro-structure.	Fracture.	Sulphur Print.	Reduction in sulphur.
1	Untreated ..	3.20	2.11	0.46	0.11	1.47	217	See Fig. 1	Coarser than the treated samples.	A little darker than 2.	—
2	Treated with mixture: 15 lbs. sodium carbonate and 11 lbs. ground limestone.	3.23	2.07	0.46	0.077	1.50	226	See Fig. 2	Finer than 1, 3 and 5.	Nearly as light as 4.	30%
3	Untreated ..	3.27	2.21	0.53	0.088	1.48	207	See Fig. 3	Same as 1 and 5.	Same as 1 ..	—
4	Treated by standard method: 15 lbs. sodium carbonate. Slag thickened with 11 lbs. limestone.	3.27	1.90	0.52	0.049	1.42	223	See Fig. 4	Same as 2 and 6.	The lightest print of the series.	44%
5	Untreated ..	3.21	1.95	0.48	0.092	1.44	207	See Fig. 5	Same as 1 and 3.	The darkest print of the series. Segregated centre.	—
6	Treated with mixture: 15 lbs. sodium carbonate and 11 lbs. ground limestone.	3.27	1.91	0.49	0.058	1.44	223	See Fig. 6	Same as 2 and 4.	Same as 2 ..	37%

One remarkable feature of the experiment is the degree of refinement of graphite when the mixture of sodium carbonate and limestone is used. This is illustrated in Figs. 1 to 6 showing a series of photomicrographs of all the test-bars made in the course of this experiment; these also demonstrate the efficiency of the mixture in removing non-metallic inclusions. There is very little to choose between iron treated with the mixture and iron treated with pure sodium carbonate, in spite of the fact that the latter method appears to produce much more violent agitation of the melt. This lends support to the theory that the refinement is not so much due to a mechanical breaking up of the graphite as to a modifying action produced by the sodium compounds present.

Whatever the explanation, this effect is of the utmost practical importance to those foundries engaged in the production of grey-iron castings, which require a close grain allied to satisfactory machining properties. Whichever method is adopted, of treating cast iron with sodium carbonate, the refining action is observed, and one particular instance has recently come to the authors' notice, in which the use of denseners in the radius between a pipe and flange has been done away with as a result of using fused sodium carbonate in the cupola.

It was observed in the course of the present series of experiments that the fluidity of the treated iron was better than that of a ladle of untreated metal, although the actual temperature, as measured by disappearing filament pyrometer, was approximately the same (about 1,270 deg. C. when poured).

To summarise the results, it has been found—

(1) That when a mixture of sodium carbonate and ground limestone is used, the reduction in sulphur is considerable, but not quite so great as by the use of sodium carbonate alone.

(2) The mixture has a very satisfactory refining action on the graphite.

(3) The fluidity of the metal is satisfactory with the mixture, and is noticeably better than that of untreated metal.

(4) Deslagging can take place immediately tapping is finished, so that there is a considerable saving in time, as compared with the standard-ladle method of treatment. This results in a higher pouring temperature.

(5) Treatment with the mixture reduces the glare of the sodium flame, making it much easier to see when the ladle is full.

(6) Treatment with the mixture is quite efficient in removing non-metallic inclusions from the metal.

(7) It would be expected that the mixture, on account of the less violent agitation which it produces, would be slightly less efficient than pure sodium carbonate as a degasifier. (Actually, the castings showed no evidence of this.)

(8) The mixture keeps the ladle very clean.

It is not suggested that the modification should displace the normal ladle treatment in all cases, but it will be of considerable service in such cases as (*a*) the manufacture of small castings from ladles of 5 to 10 cwts. capacity; (*b*) in mass-production foundries where the time required for thickening and removing the slag would delay production, and (*c*) when the time taken by the standard method results in a stiffening of the metal, as in casting low-phosphorus or low-silicon mixtures.

Viscosity of Slags.—In "Metallurgia Italiana," L. Losana describes the determination of the viscosity of slags at different temperatures by means of the torsion method, using slags obtained from the open-hearth furnace and the electric furnace and containing different proportions of iron and manganese oxides. The effect on the viscosity values of adding fluorspar to the charge was also studied.

"Pyroptic" Inspection Window.

It is not necessary to emphasise that a regular inspection of the interior of metallurgical furnaces of all kinds is of the greatest assistance in obtaining efficient results. The observation of furnaces cannot, of course, be carried out with the naked eye, because of the blinding effect, and to wear special coloured glasses, or carry a piece of smoked glass, is a crude and troublesome proceeding.

In this connection, however, Liptak Furnace Arches, Limited, of London (38, Victoria Street, S.W.1), supply neat and efficient "Pyroptic" inspection windows (H. G. B. Mahon patent). These are fitted permanently in any part of the setting, either the doors or walls, and consist of a metal framework carrying a comparatively large area of tinted glass through which a complete view of the interior of the furnace is obtained in comfort. The main problems concerned with the efficient design of windows of this kind are to prevent the glass cracking by

The "Pyroptic" Furnace-Inspection Window.

the high temperature as well as rapid changes of temperature, and also to ensure reasonable freedom from mechanical breakage, as well as clearness for a considerable period without cleaning. These requirements are obtained in the "Pyroptic" window on most ingenious lines.

The tinted glass is in the form of a composite panel made up of a number of narrow strips fixed horizontally one above the other with the joining edges bevelled. This latter device prevents any white light passing between adjacent strips to the eye. Included also are two ¼-in. thick plates or slabs of clear fire-proof glass on the furnace side, and one similar plate on the outer side which absorbs some of the radiant heat, on the accumulator principle, before it reaches the tinted glass. Consequently the latter is kept at a more or less uniform temperature without fear of cracking due to sudden changes of temperature in the furnace chamber or by swinging open the windows, and therefore exposing to the cold air. Further, the glass is free to expand and contract so that no internal strains are caused.

It is claimed the windows can be exposed for long periods to a temperature even as high as 1,535° C. without injury. In one design this composite glass window is hinged on to an adaptor plate so as to allow of easy removal from the frame for cleaning. Another and more advanced pattern of window has a heat-resisting metal shutter which protects the glass from the heat when the window is not being used. The shutter is attached by two chains to a small overhead shaft with a short lever which is pulled down by hand when an observation has to be made so as to uncover the tinted glass. Even for the most severe conditions, it will be noted, the view in both cases is uninterrupted by grids.

Studies on Solidification and Contraction and Their Relation to the Formation of Hot Tears in Steel Castings.

By Charles W. Briggs and Roy A. Gezelius, Washington, D.C.

(*Concluded from page* 174.)

The External Hot Tear.

The external hot tear develops after solidification is complete, but while the casting is at a temperature slightly below the solidification temperature, and it is caused by stresses due to mould resistance. The reason that the crack has been termed external hot tear is that the crack first opens on the surface of the casting and proceeds inward. Such a crack has the appearance of a tear; that is, the face of the crack is ragged. The crack is wider at the surface and is uninterrupted in depth.

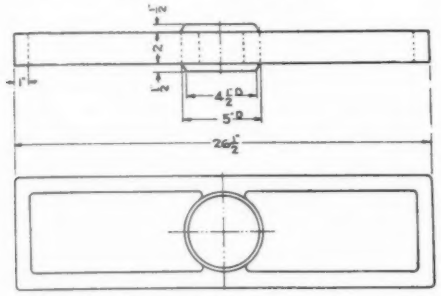


Fig. 9.—Pattern used in the Study of External Hot Tears.

The cracking or the failure of such a casting would be comparable to the failure of a test specimen under load at a high temperature; the cracking begins at surface irregularities which serve as points of stress concentration. It is obvious that mould resistance will depend upon the shape of the casting and the conditions of the moulding sand. A mould that is collapsible in the danger zone can render the detrimental forces of contraction less effective.

In the study of external hot cracks, a pattern involving a hub and arm as shown in Fig. 9 was moulded in three ways:—(1) In dry sand; (2) in green sand; and (3) in green sand made more collapsible by hollowing out that portion between the arms. The radiographs of Fig. 10 show the amount of cracking as obtained by the variation of mould resistance. It will also be noticed that the cracks are wide at the surface and become smaller as they penetrate the metal. The casting made in the collapsible mould shows no cracks at all. It may then be assumed that mould resistance caused the cracks, and that the greater the mould resistance, the larger the crack. There is little possibility that these cracks formed before solidification was complete, since there is no evidence of large internal tears.

Measures Employed to Obviate Hot Tears.

The formation and development of hot tears having been studied, it appears wise to consider methods that may be adopted to obviate the danger of hot tears, or at least to limit the tendency of hot-tear formation. In this regard, the following measures are employed:—(*a*) Flexible moulds and cores; (*b*) the use of chills at the proper places; (*c*) the application of ribs and wedges at certain changes of cross-section; (*d*) the use of a thermal non-conductive moulding material; (*e*) casting in preheated moulds; (*f*) pouring from elevated temperatures; and (*g*) casting design.

Collapsible Moulds and Cores.

It has been stated already that flexible moulds and cores have a beneficial effect. Considerable time must be used in producing such moulds, and the sand recovery after moulding often is very difficult when cinders and the like are used in backing up parts of the mould and in the centre of cores. The use of such moulds, of course, is limited. The data concerning the critical cracking temperatures show how important it is to keep moulds and cores collapsible so that their resistance does not cause cracks. In many cases, in order to prevent cracking, the mould and cores must be destroyed immediately after casting. Immediate action is necessary because, according to the experiments of Körber and Schitzkowski and personal data in the case of thicknesses of from 20 to 50 mm., a period of only 2 to 4 mins. intervenes between filling the casting and reaching the critical cracking temperature in the neighbourhood of 1,300 deg. C.

Mould resistance arising from the negligent use of core irons has been repeatedly pointed out by G. Batty.[19] He claims that utmost care should be used to see that core irons are straight and pointed on the ends, so that they will not interfere with the collapsibility of the core. Great pains are taken in European plants to obtain mould collapsibility by the use of relieving blocks, cinders and the like. All tie rods and reinforcing bars are placed in such a manner that they protrude from the ends of the box. This prevents the mould resistance that would arise from the sand compressing between the ends of the bars and the box.

The Use of Chills.

The use of chills is always a very uncertain measure, and their presence is likely to cause cracks, the very thing that it is so desirable to eliminate. Theoretically, chills cool portions of the casting that otherwise would remain fluid longer than the surrounding portions through which the larger section is fed. If chills of the correct size are used, the process of directional solidification would be aided, with the result that the formation of hot tears would be unlikely. In other words, the chill acts as a method for reducing the dimensions of the piece, and the dimensions of the piece as well as the fluidity of the steel at the time of pouring determine how long contraction and solidification continue.

To overcome poor design—it is really only because of poor design that chills are used at all—is rather difficult. In the first place, the amount of cooling should be known, and the answer at best is only a guess. Thus, the mass of the chill is merely estimated. If the chill is estimated as a greater mass than is really required, then the section is over-chilled and contraction stresses are set up in a manner opposite to that which would have been experienced if no chill were used, with the possibility of the formation of a hot tear.

It has been observed that the use of too large a chill plate may crack a casting, due to a too-rapid development of shrinkage stresses. Likewise, a centre of solidification is started which in many cases may not be desired. If the mass of the chill is less than that required, then solidification will not proceed as rapidly as is necessary to ensure a sound section. The discussion above has applied, in particular, to external chills. The use of internal chills is even more critical. If the mass of an internal chill is too large, it will not fuse in, and along with the detrimental features just pointed out there will be the added one of lack of cohesion of the metal. Internal chills should be clean and dry, otherwise porosity is apt to result.

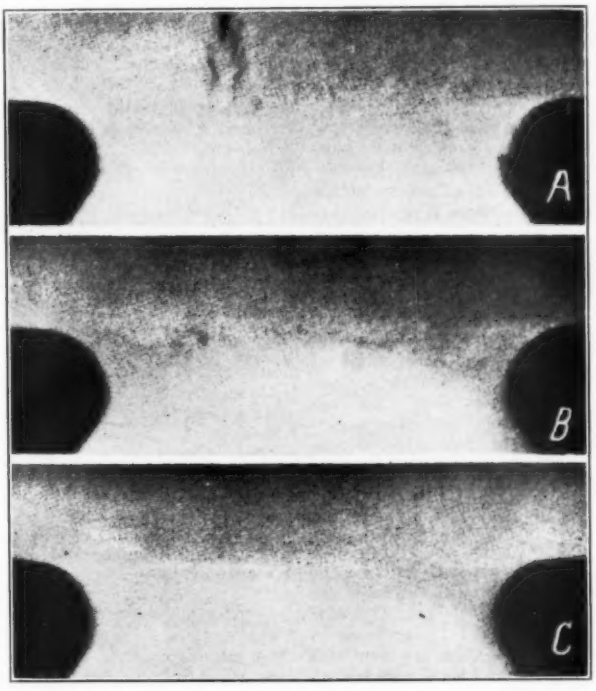


Fig. 10.—External Hot Tears as obtained by Variation of Mould Resistance. *A:* Casting made in Dry Sand. *B:* Casting made in Green Sand. *C:* Casting produced in Collapsible Green-Sand Mould.

It is the authors' opinion that internal chills are more conducive to the formation of hot tears and other internal defects than they are to obviate these dangers. Their use is not scientifically controlled, and the dangers arising from their misuse are many. Whatever can be accomplished by chills may be attained by the use of external chills with less danger of harmful results. It is true, of course, that the use of

external chills involves more expense, since usually it is necessary to cast them in advance in order that they will fit the section which is to be chilled.

Application of Ribs (Brackets).

The application of ribs has served to check hot-tear formations. They have been used rather extensively in this country with fairly good results. Their function is to solidify earlier than the sections which they adjoin, and in this manner act as a bond in preventing cracking. Ribs do not eliminate the contraction stresses; they merely tend to prevent these stresses from centralising at one point and rupturing the casting. The strength added to the surface skin by the presence of ribs acts to transfer converging stresses over a wide area. With some castings even a generous supply of ribs will be of no use; although the ribs themselves remain solid, cracks occur between them. In such cases the designer must come to the aid of the foundryman by providing for gradual transitions and smaller junctions between the sections of varying thickness.

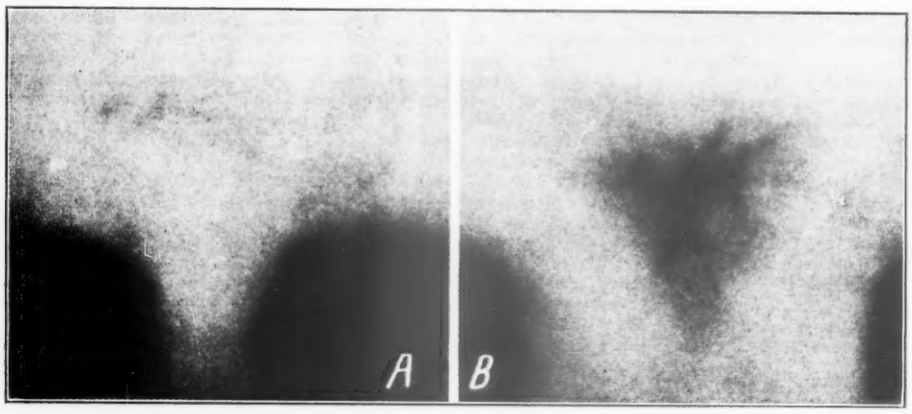


Fig. 11.—Gamma Ray Radiographs showing Influence of Individual Adjoining Sections.

The use of wedged-shape attachments to the casting on which gates and risers rest often are advisable, because all measures that are taken to prevent the formation of pipes in the casting will effectively lessen the danger of hot-tear formation. A disadvantage in the use of ribs and wedge-shaped attachments is their removal cost, which sometimes is considerable. A few other points should be considered in the prevention of hot-tear formation. It has been previously shown that contraction stresses that arise suddenly within a casting are most conducive to hot-tear formation. In order to take steps to prevent these stresses from arising so suddenly, a slower rate of solidification must be effected. Even if this is not entirely possible, any steps that can be taken in this direction must have a good effect.

Of course, the first suggestion is to increase the wall thickness of the casting, for the greater the section the slower the cooling. However, in some cases this is not altogether desirable or feasible. The three other alternatives that are available are the use of thermal non-conductive moulding material, casting in preheated moulds and pouring from elevated temperatures.

The Use of Thermal Non-Conductive Moulding Material.

It has been noticed that a skin forms quickly when molten steel is poured into a mould. The thickness or degree of formation of the skin depends largely upon the rate with which the mould material can conduct the heat away from the solidifying casting. Thus, the chilling action of the material of the mould has a great effect upon the rate of solidification of the steel. If the mould material could be made less conductive of heat, the chilling action would be somewhat lessened. It is obvious that sand is much better in this regard than is a metal mould. A moulding material that would have poor conducting properties must also have the good qualities that sand possesses, namely, adequate refractoriness and good mouldability. These properties narrow the field perceptibly.

There remains magnesium oxide in one form or another, lime (plaster of Paris), asbestos and diatomous earth, and even these have various objectionable features. Asbestos and plaster of Paris lack good permeability, magnesium oxide and diatomous earth have little strength, and diatomous earth has such a high porosity that it would give trouble in casting because the air enclosed in the pores must escape in consequence of its expansion upon being heated. This air may attempt to escape through the steel, which would cause a porous casting.

It seems that, for one reason or another, these materials have limitations. However, they can be used in a mould, especially if they are used in combinations such as asbestos shreds and magnesium oxide of diatomous earth. A great mouldability is thereby obtained and the heat conductivity considerably lowered. If these poor heat conductors are placed at the thin portions of the mould and the better conducting materials used at the thicker portions, a more even directional solidification may be obtained.

Casting of Preheated Moulds.

In regard to casting in preheated moulds, it may be said that this is an excellent way to get around the excessive chilling action of the mould material. In a way, the same object is accomplished as in the use of thermal non-conducting materials, since the molten steel coming in contact with the warm walls of the mould does not cool so rapidly. The preheating cannot be carried on at high temperatures, since the mould will crumble from lack of bond strength; then, too, the process is not favourably received because it causes difficulties in manufacturing schedules.

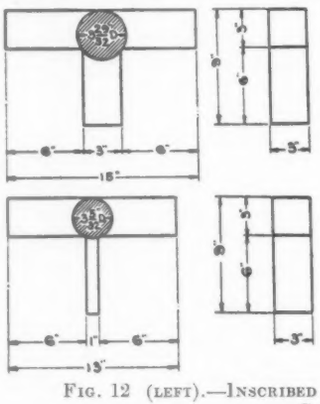


Fig. 12 (left).—Inscribed Circles as applied to Adjoining Sections.

Fig. 13 (right).—Application of Inscribed Circles as an Aid to Design in a Rib Section. (After Heuvers.)

Pouring from Elevated Temperatures.

Pouring from elevated temperatures as a means to avoid hot tears probably sounds like a foolish suggestion to most experienced steel foundrymen, whose slogan for years has been "Pour cold and prevent cracking." This opinion is urgently in need of correction. Steel poured hot will give excellent castings, and if it is a well-made, well-refined steel, thoroughly deoxidised, it will not have as great a tendency to the formation of hot tears as that which is poured cold. A great number of steel casting manufacturers do not make steel for castings, but merely melt steel for casting; consequently the formation of the slogan "Pour cold."

It should be understood that the moulds used in conjunction with pouring from elevated temperatures must be made of material which (*a*) will not readily be eroded by the high temperature metal, and (*b*) will not materially resist the progress of normal solid contraction of the casting. The gating and heading should be so devised as to ensure good directional solidification. Karl Singer,[13] one of the exponents of superheated steel, is of the opinion that the general idea that hot steel has a greater tendency to crack arose from the fact that the hot melts, which are richer in oxide, usually are not treated any differently from the colder melts and that the deoxidation of the steel bath therefore is not carried far enough. The result of this is that the hot melts are more often poured with a higher oxygen content. The FeO, which is already separating out at the time the hot cracks are formed, lessens the slight tensile strength of the hot metal and thereby increases the danger of cracking. It is Singer's opinion that oxygen, or iron oxide, is a factor in formation of hot tears.

Regardless of the actual causes, the fact that steel poured hot produces satisfactory castings is established, and the reason for the greater tendency to hot-tear formation in castings made with hot steel cannot be attributed to the temperature. The pouring of a well-deoxidised steel from elevated temperatures, such as may be obtained from the electric furnace, will be found to be of advantage in casting thin-walled pieces with a tendency to crack.

If it is assumed that hot tears form during the transition of the steel from the plastic to the solid condition, then it can be shown that the temperature of the steel as poured is very important. For example, a high casting temperature will allow for a slow solidification of the casting, as the mould metal interface is superheated. Shrinkage stress will not arise suddenly, and a more uniform directional solidification can take place. An advantage of low-temperature pouring is that a substantial elastic crust, capable of absorbing quite high-tension stresses, forms while the mould is being filled. One of the disagreeable things arising from the use of low-temperature steel is the increasing proportion of entrapped gases. The thickly fluid steel should be limited to heavy

sections. The principle of directional solidification should always be used. Thin-walled sections that are liable to crack should be poured with superheated steel. Allowance must be made, of course, for the extra liquid contraction that takes place and for obtaining a well-made steel.

In summing up these points, it is the authors' opinion that the principal advantage of retarding solidification lies in the fact that an equalisation of temperature takes place in the crust first solidified. By keeping the steel fluid in the mould for a longer time, directional solidification can be more readily controlled and suddenly-applied stresses more easily eliminated.

Design.

In a Paper of this type the question of design should be given some attention. There is much to be said on so important a question, but to present a thorough study of it is not within the scope of this article. There are as yet no definite rules of design which can be promulgated for every case, but it is possible to take specific cases and from them point out some generalities which might apply to similar designs. This has been done so frequently in the past that it is hardly necessary to mention more than a case or two until such a time as, it is hoped, more definite knowledge will be available to enable one to state what is the best design.

A study of proper design must include all of the factors mentioned previously in this article. It is scarcely to be expected that the most expert of designers will possess knowledge of the possibilities and limitations of foundry practice. Real co-operation should exist between the designer and foundryman in order that both may profit by the economies in time and money thus effected.

Statements of this kind have appeared so frequently in recent technical Papers that they are no longer novel. In spite of this fact, no great steps toward co-operation have appeared. It may be true in isolated cases that a genuine endeavour is made to bring about an understanding between the foundryman and his customer, but such cases are rare and do not apply to the industry as a whole.

In most cases the foundryman never sees the pattern until it arrives at his plant to be moulded. Then, even though he knows it should be modified, he usually says nothing for fear he may lose the order or cast reflections upon his own ability. In many cases he would be money in pocket. Most foundrymen will agree that a great many designs are unnecessarily difficult for foundry production. They are also agreed upon the fact that each casting is a problem in itself, and that foundry practice is an art and cannot be bound by definite rules or regulations.

The authors agree whole-heartedly with the first statement, but not entirely with the second. It is true that each casting as it is designed now is more or less a problem in itself. Even so, there are many general rules which apply to all castings and which every foundryman uses, subconsciously or otherwise.

However, there are at present no rules or limitations which apply to the designer. His main purpose is to design a casting that will perform the desired task with a minimum amount of weight and be at the same time pleasing to the eye. He has no knowledge of, and as a rule is not concerned with, the difficulties which may be met in production. He seldom realises that in many cases he jeopardises the entire casting for a small loss in weight or a slight gain in "beauty." Accumulations of material are amongst the greatest dangers tending toward pipes and cracks. For constructive reasons it is not always possible to avoid them, but the designer can minimise the danger by providing gradual transitions from light to heavy sections. Heuvers[11] has suggested a "simple and convenient method whereby the influence of individual cross-sections may be determined." This consists merely of inscribing circles within the cross-sections to be examined. The value of the method can readily be illustrated by examining the two radiographs (Fig. 11) of ribs of two sizes joined to sections of an identical cross-section.

In the diagram (Fig. 12) these two sections are shown with the circles inscribed. It will be noted that the inscribed circles in each arm of the first T-section is 3 in. in diameter, whereas at the junction of the arms the diameter is $3\frac{29}{32}$ in. In the second T-section the rib is but 1 in. thick and the inscribed circle has a diameter of $3\frac{5}{32}$ in. The radiograph of the larger cross-section shows a flaw in the larger circle representing the accumulation of material. The second radiograph also shows a flaw, but one considerably smaller than the other.

Other instances where design could be improved are made clear by two further examples. The first, shown in Fig. 13, is merely a section of a tube designed with a rib or foot such as frequently serves to support pipe sections. The design usually chosen is represented on the left. A design recommended by Heuvers and used to some extent in Europe attains the same purpose, and although it is less pleasing to the eye, is decidedly preferable from the standpoint of foundry technology. The accumulation of

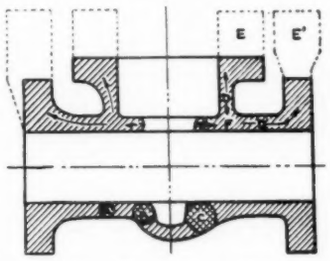


Fig. 14.—Directional Solidification as applied to a Valve Body.

material in the design on the left, as shown by the areas of the inscribed circles, is 80 per cent. greater than that of the more correct design. The second example (Fig. 14) is a portion of a commercially-designed valve body. The right half of the cross-section shows the original design; the left half has been modified by the authors. The dotted lines indicate portions that are to be removed by machining, and the arrows indicate what the authors believe would be the direction of solidification.

The changes in section on the modified side are all gradual and tend to reduce the accumulation of material or to produce controlled directional solidification. Using Heuvers' method of inscribed circles to examine the casting, it will be noted that circle A, representing the average wall thickness, has a diameter of $1\frac{1}{2}$ in.; and that circle C, representing the original design, has a diameter of $2\frac{1}{2}$ in., or an increase of 186 per cent. in accumulated material. By modifying the casting somewhat, a section as shown by circle B of $1\frac{3}{4}$ in. dia. may be obtained. This represents an increase in accumulated material of 36 per cent., which, although not perfect, is decidedly better than the original design.

The modifications on the flanges are similar to those pointed out by Wheeler[20] and, although they apparently cause an accumulation of material, simplify matters greatly by introducing controlled directional solidification. By examining the arrows on the original design, it will be noted that, as solidification will begin at the thinner sections, points D, D′ and D″ will solidify first and solidification will proceed from these points. It then becomes apparent that, as far as feeding the hot point F is concerned, the heads E and E′ are worthless. The head E cannot feed beyond the section D, the head E′ beyond the section D′, and the appearance of a cavity at F is highly probable unless other precautionary measures are taken to obtain directional solidification.

If the modified design is examined, it will be seen that solidification is more or less controlled and will proceed toward the heads, and thus maintain an open avenue for "feed metal" until the head itself has solidified. To obtain this end the head must be carried down the side of the flange, as otherwise the head itself might solidify before the heavy portion of the flange.

The studies on the formation of hot tears are in their infancy, and plans for a more complete research have been formulated. In the radiographic inspection of castings being purchased by the Navy, many conditions of external and internal hot tears have been observed. The fact that there are so many contradictory opinions regarding the nature and conditions of their formation has led the authors to express the above notes in the hopes that there will be greater cognisance of steel castings' most formidable defects, namely, the hot-tear formation cracks.

Summary.

Casting solidification involving the principle of equal cooling throughout is undesirable. Such conditions should be replaced by the more natural method of directional solidification. Controlled directional solidification is successful only when certain principles of casting design are adopted. These principles stress the importance of feeding smaller sections through heavier ones and by studying mass effect by the use of inscribed circles. Metal contraction and hindered contraction resulting from mould resistance is responsible in the major part for the existence of hot-tear cracks in steel castings. Other important factors are cavities and the physical properties of the steel.

There are two types of hot-tear cracks:—(1) The internal hot tear that develops during the solidification of the casting; and (2) the external hot tear that develops after solidification is complete, but while the temperature is about 1,300 deg. C. Intelligent application of certain principles in casting design is one of the most important of seven methods that may be adopted to obviate the danger of hot tears, or at least to limit the tendency of hot-tear formation.

Acknowledgment.

The authors wish to take this opportunity of expressing their appreciation to Commander E. D. Almy, U.S.N., Director of the Naval Research Laboratory, for the interest and enthusiasm he has shown in the steel-casting research project. It was largely through his efforts that a basic research on steel castings was inaugurated.

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Catalogue Received.

Portable Lamps.—Salora Lights, Limited, of 52, Guildhall Buildings, Navigation Street, Birmingham 2, have sent us a copy of a 15-page catalogue which describes and illustrates a new type of portable lamp giving an intensely bright ray. For the foundry industry it suggests itself as being eminently suitable for night watchmen. It is, we understand, being used by fire brigades, and we learnt that these useful bodies detest fires in moulding shops owing to the alleged irregularity of the terrain! The apparatus, which is known as the "Kim" portable searchlight, is extremely compact, and is capable of giving a full, medium and dim light through the intermediary of a handy switch.

This Week's News in Brief.

Trade Talk.

Messrs. W. Canning & Company, Limited, are presenting up-to-date equipment for use in the electro-plating classes at the Birmingham Central Technical College.

Sidney Flavel & Company, Limited, announce that a new share capital issue of £32,000 is being taken up by the present directors, Mr. Percival Flavel, J.P., Mr. Gilbert Flavel and Mr. S. W. B. Flavel.

Sir John M. MacLeod, C.A., Glasgow, has notified the joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board that the examination of the employers' books for July and August showed the average net selling price to be £9 12s. 9.36d. There will be no change in the wages of the workmen.

British cream separators are to be exchanged for Canadian ploughs. An arrangement to this effect has just been concluded between Messrs. R. A. Lister & Company, Limited, of Dursley (Glos), the biggest cream-separator manufacturers in the British Empire, and the Cockshutt Plow Company of Canada, the biggest tractor-plough makers in the Empire.

Messrs. Ardrossan Dockyard Company, Limited, have received another order to build a motor-driven coaster for British owners. This is the third order received by the Ardrossan yard since the beginning of the year for motor-coasting vessels. The new boat, which will be to the special design of the firm, will be of the most up-to-date type and have a carrying capacity of about 450 tons deadweight.

After extensive remodelling and reconstruction, including an increase in the hearth diameter from 12 to 16 ft., Messrs. Dorman, Long & Company, Limited, Middlesbrough, are to put into operation this month at their South Bank Works an additional blast furnace for the production of basic iron. Formerly producing 200 tons per day, it is hoped to attain an output of double that quantity, and the whole of the iron will be used in the adjoining steelworks.

The directors of Murex, Limited, in view of the continued expansion of the company's business and activities involving heavy capital expenditure and the carrying of larger stocks both by the company and its subsidiary, Murex Welding Processes, Limited, and also to new developments which the company has under contemplation, propose to increase the ordinary capital from £200,000 to £225,000 by the creation of 50,000 new ordinary shares of 10s. each.

Accommodation has been fully booked for the annual "James Watt" dinner of the Institution of Engineers and Shipbuilders in Scotland, which is to be held in Glasgow on October 13. The function is regarded as the principal social event of the year amongst technical institutions in Scotland, and among those who have accepted invitations to be present are Lord Stonehaven, President of the Institution of Naval Architects; Mr. A. Noel Skelton, M.P., Under-Secretary of State for Scotland; Sir Steven Bilsland, Sir James Lithgow, Lord Provost Swan and Sir Lewis Shedden.

There are 35 vessels under construction on the Clyde at present, six of which are fitting out. This is the busiest spell the river has had this year. The latter vessels are a Portuguese destroyer, a large cargo steamer, a passenger and cargo motorship, a motor coaster, a passenger and cargo steamer and a tanker. Further signs of the improving times are to be found in the Gareloch shipping "barometer" on the Clyde. Within the past week or two the City Line have recommissioned several of their vessels which were lying in the loch, and now the number of ships laid up there is 19. The oil tanker "Imperial Transport" (8,000 tons) has also been removed from the Holy Loch for service.

As from October 1 the directors of Messrs. Turner & Newall, Limited, are consolidating the manufacture and sale of asbestos cement and asbestos electrical insulation goods into one organisation, which will trade under the name of Turners Asbestos Cement Company (Branch of Turner & Newall, Limited). The consolidated organisation will have its headquarters at Trafford Park, Manchester, and works and branch offices throughout the country. This step follows the declared policy of the company of combining into one branch of Turner & Newall, Limited, all interests of an analogous nature, and in this case four subsidiary companies—Turners Asbestos Cement, Limited, Asbestos Cement Building Products, Limited, Bell's Poilite & Everite Company, Limited, and British Fibrocement Works, Limited—will be effectively wound up. To a large extent the reorganisation has already been effected.

Confirmation of the sale of the Ormesby Ironworks, Middlesbrough, to the Stanton Ironworks Company, Limited, is forthcoming in the published announcement of the formation of a private company with a nominal capital of £100 in £1 shares, "to acquire the undertaking of the pipe-line business, foundry and works carried on by Cochrane & Company, Limited, at the Ormesby Ironworks, Middlesbrough . . . and to enter into an agreement between Cochrane & Company, Limited, of the first part and the Stanton Ironworks Company, Limited, of the other part." The subscribers, each with one share, are H. N. Sporborg and C. H. Scott, both solicitors, of 18, Austin Friars, London, E.C.2, and the first directors are to be appointed by the subscribers. The works have recently been part of the Furness group of iron and steel works, and local inquiries indicate that it is the intention of the new proprietors to continue, and possibly to extend, operations.

Company Reports.

Thos. W. Ward, Limited.—Net profit, £105; brought in, £18,287; carried forward, £18,393.

Stewarts & Lloyds, Limited.—Interim dividend on the preference shares for the half-year ended June 30, 1933.

Vulcan Foundry, Limited.—Dividend on the ordinary shares of 2½ per cent. for the year ended June 30.

Edgar Allen & Company, Limited.—Payment of the dividend on the cumulative preference shares in respect of the half-year ending September 30 is deferred.

Murex, Limited. — Net profit, after reserving £8,000 for income tax, £55,411; brought in, £34,204; final dividend of 20 per cent., making 30 per cent. for the year; carried forward, £44,150.

Contracts Open.

Dunblane.—Supply and laying of 2,500 yds. of 3-in. water pipes, for the Fife County Council. Messrs. H. J. Bell & Company, chartered surveyors, 18, Charlotte Street, Perth. (Fee £1 1s., returnable.)

Singapore, November 6.—Iron pipe fittings, for the Singapore Municipality. The Department of Overseas Trade. (Reference G.Y. 12,983.)

Company Meeting.

W. H. Dorman & Company, Limited.

At the annual meeting of Messrs. W. H. Dorman & Company, Limited, held in London recently, Mr. Walter Haddon (chairman and managing director) said that during the first five months of the current year there had been an improvement on the petrol-engine side and also a steady increase on the Diesel-engine side, so that their sales for this period were at least 100 per cent. up.

Obituary.

The death occurred, on September 22, at St. Aubyn's, Kinnear Road, Edinburgh, of Mr. John Thomson Ramage, of Messrs. Ramage & Ferguson, Limited, shipbuilders, Leith. Mr. Ramage, who was in his 69th year, was the son of Mr. Richard Ramage, who, along with Mr. John Ferguson, founded the firm of Ramage & Ferguson. He served his apprenticeship with his father's firm, and then spent some years with the Fairfield Shipbuilding & Engineering Company, Limited, Govan, Glasgow. Later he studied engineering at Owens College, Manchester. He was appointed a director when the firm was converted into a limited liability company, and took special charge of the engineering department of the works. He was a member of the North-East Coast Institution of Engineers and Shipbuilders.

Personal.

Mr. P. H. Mills, hitherto general manager of Messrs. W. & T. Avery, Limited, Birmingham, has been appointed managing director of the company in place of the late Sir Gilbert Vyle.

Messrs. Birchall & Company (Oils), Limited, Metier Works, Rochdale, announce that Mr. A. Jackson, of Birmingham and Leeds, has been appointed their representative for the Midlands and West Yorkshire areas. Mr. A. Jackson was at one time chief chemist at the Low Moor Iron Works.

Mr. John True, of Motherwell, was seriously injured last week during the course of his employment in the works of the Lanarkshire Steel Company, Limited, Flemington. He was burned by slag splashing from a ladle, and in getting clear fell heavily, sustaining serious head injuries.

Mr. and Mrs. William Reid, of Hardgate, Dumbartonshire, have celebrated their golden wedding. Both are natives of Kilmarnock, and Mr. Reid served for over 50 years with the Singer Manufacturing Company, Limited, Kilbowie. He was until he retired about five years ago foreman in No. 6 Department.

Mr. George Porteus, of Bonnybridge, an employee of Messrs. Mitchell, Russell & Company, Limited, Chattan Foundry, Bonnybridge, has received a presentation from the staff of his department on the occasion of his leaving the works to assume the *rôle* of under-manager of a Harrogate musical combination. Mr. Porteus was well known as the leader of a local dance band.

Mr. George Senior, who has for so many years been in charge of the sales of Messrs. General Refractories, Limited, Genefax House, Wicker Arches, Sheffield, 4, was recently elected to a seat on the board of the company.

Mr. George Senior.

Mr. John O. McLaren, President of McLaren Soc. Anon., of Buenos Aires, is now in England. He expects to remain in Europe for about three months. His firm are leading importers in Argentina of iron and steel materials for railway and marine use, refractories, and general engineering products. The Editor will forward any correspondence from exporters wishing to get into touch with Mr. McLaren.

Mr. T. R. Hill, who has been connected with Messrs. Henry Edie & Company, Limited, the Bow Foundry, London, for 47 years, has been appointed a director, and to mark the occasion a smoker's cabinet, suitably inscribed, has been presented to him by the workmen and staff. The presentation was made by Mr. H. Scott, A.M.I.Mech.E., manager, and Mr. Hill, in returning thanks, recalled some interesting experiences during his long career at the foundry.

Mr. K. S. Murray has signified his intention to resign his positions as chairman and managing director of the British Oxygen Company, Limited, on December 31 next. Mr. Murray has contemplated this step for some years, but delayed taking it until the reorganisation of the business, necessitated by amalgamations, had been completed. This has now been done, and Mr. Murray feels that the time has arrived when he can delegate his duties to his colleagues. Subject to the approval of the shareholders at the next annual meeting, Mr. Murray has been appointed honorary governor for life, in recognition of his invaluable services to the company for close on fifty years. He has been invited, and has agreed, to accept the position of consulting engineer to the company, so that his unrivalled experience in the business will continue to be available.

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Raw Material Markets.

Business is gradually improving in the iron and steel markets, and the next three months will see an increased volume of employment. The consumption of pig-iron is at a satisfactory level. Not a great deal of new business is being done, as most consumers have already contracted for supplies until the end of the year. An increase has been made in the price of East Coast hematite, but otherwise pig-iron prices are unchanged.

Pig-Iron.

MIDDLESBROUGH.—The Cleveland iron market continues to strengthen in tone. Consumers are not hesitating to buy freely, both for spot and forward delivery. There are at the moment only two Middlesbrough furnaces producing foundry iron, and the makers' stocks are being rapidly depleted. It is true that another furnace is being restarted, but it is to produce basic iron for the use of the associated steelworks. Thus, in view of the limited supplies, and the increasing hardness of the coke market, consumers' fears of higher pig-iron prices are justified. For the time being, however, quotations remain as follow:—No. 3 Cleveland G.M.B. foundry iron, 62s. 6d. delivered Middlesbrough, 64s. 6d. delivered North-East Coast, 62s. 3d. delivered Falkirk, 65s. 3d. delivered Glasgow. No. 1 foundry iron is 2s. 6d. higher than the above prices, and No. 4 foundry and No. 4 forge iron are offered at a discount of 1s. per ton.

An increase of 1s. per ton has been made in the price of East Coast hematite, mixed numbers now being at 60s. per ton and No. 1 quality at 60s. 6d. The makers are not very anxious to book orders for delivery before the end of the year even at these figures, as they are already well booked up. The rise in prices follows upon the closer understanding which has been arrived at lately between the producers.

LANCASHIRE.—Generally speaking, the Lancashire pig-iron market has continued to lag behind other districts. Only a limited number of new orders has been placed from week to week, the majority of which have been for delivery up to a month ahead. However, there has been slightly more activity since the turn of the month, and it is hoped that an improvement will be seen. The lighter branches of the consuming trades are fairly well employed, but the heavy engineers are still short of work. Prices for delivery to users in the Manchester area are unchanged, 67s. per ton being quoted for Derbyshire, Staffordshire and North-East Coast brands of No. 3 iron, with Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at around 80s., East Coast hematite at about 74s., and West Coast at 80s. 6d. Imported Indian iron is finding an outlet among certain Lancashire foundries, at the expense mainly of Scottish brands, the delivered prices for the former being about 70s. per ton. Scrap materials range from about 35s. up to 42s. 6d. per ton, according to quality and locality, including delivery to buyers' works.

MIDLANDS.—The demand for pig-iron from Midland light-castings makers is fairly satisfactory, whilst the call from the general ironfounders is also becoming more active. Not a great deal of new business is being transacted, as most users are already covered until the end of the year. A meeting of the Central Pig-Iron Producers' Association was held last week, when it was decided to re-affirm the existing price list. This remains as follows:—62s. 6d. per ton for Northants No. 3 and 66s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, including delivery to Birmingham and Black Country stations, and subject to a graduated rebate for large consumers. Continental foundry iron remains without interest to local consumers on account of the price, and only small supplies of Cleveland iron are coming into this district. There is, however, a fair demand for irons of a special nature for particular trades. Medium-phosphorus pig is at anything from 70s. to 80s., and low-phosphorus from 80s. to 90s., with Scottish No. 3 at 85s. per ton. Special refined irons for the motor and engineering trades range from £5 to £6 15s. delivered this district.

SCOTLAND.—Trading continues on dull lines in the Scottish pig-iron market, most foundries declining to enter into long-term contracts, although the majority have still a fair amount of work on hand. They are still being asked to pay 65s. for No. 3 foundry f.o.t. furnaces, with 2s. 6d. per ton extra for No. 1. For No. 3 Middlesbrough they are paying 62s. 3d. f.o.t. Falkirk area and 3s. per ton more f.o.t. Glasgow area. Lincolnshire and Northamptonshire irons are 1s. 3d. to 2s. 3d. per ton less.

Coke.

Quotations remain unchanged in the foundry-coke market. Rather more forward buying is being put through at the moment. Prices are:—Best Durham coke, 36s. to 38s. per ton; other grades, 2s. 6d. less; Welsh coke, 30s. to 45s., according to analysis; Scottish low-ash coke, 39s. to 40s., all delivered in the South Staffordshire area.

Steel.

The steady conditions noticeable for the past few weeks are well maintained, and there is a strong tendency for business in the home market to expand. In the semi-finished steel department active conditions rule. Most of the producers of this class of material are working at a high rate of capacity, and in some cases are unable to give delivery before the end of the year. A few transactions in Continental material are occasionally reported, but the quantities imported are comparatively insignificant, and in most cases the foreign material is required for special purposes. Conditions in the finished-steel department of the market are also satisfactory, and although competition from Continental works is experienced in the home market, this has not resulted in much business going abroad. The British steelmakers are finding a good demand, and the position of this branch of the trade is steadily improving.

Scrap.

There is a good demand for scrap-iron in the Cleveland district, and merchants are asking 42s. 6d. per ton for ordinary metal and 45s. for machinery. Light cast iron is at 38s. 6d. to 39s. 6d. There continues to be a steady call in the Midlands, quotations being firm. The Scottish market remains firm, conditions being unchanged from last week. In South Wales, heavy cast iron in large pieces and furnace sizes is a quiet trade at about 45s. to 47s. 6d., but there is a fair demand for light cast-iron scrap at 41s. to 42s. 6d. Good machinery scrap is quiet at about 47s. 6d. per ton.

Metals.

Copper.—The standard market ended last week at a level of £34 17s. 6d., but recovered on Monday to £35 10s. Market sentiment is rather firm at the moment. There has been a little more demand from consumers recently, but, generally speaking, the demand for copper manufactures is still limited. It cannot be said that the situation in the United States has actually improved, but there is a feeling that prospects are slightly better. It is noted that the American consumption of beryllium-copper alloys is reported to be moving upwards.

Discussions are proceeding at Geneva on the possibility of arriving at an agreement on the production and distribution of copper. It is proposed to hold a conference of the countries concerned, following the precedent set by the recent "wheat pact."

The week's prices have been as follow:—

Cash.—Thursday, £34 11s. 3d. to £34 13s. 9d.; Friday, £34 17s. 6d. to £35; Monday, £35 10s. to £35 11s. 3d.; Tuesday, £35 3s. 9d. to £35 5s.; Wednesday, £34 17s. 6d. to £35.

Three Months. — Thursday, £34 15s. to £34 17s. 6d.; Friday, £35 to £35 1s. 3d.; Monday, £35 13s. 9d. to £35 15s.; Tuesday, £35 7s. 6d. to £35 8s. 9d.; Wednesday, £35 2s. 6d. to £35 3s. 9d.

Tin.—Tin quotations on the London Exchange made an upward move under the influence of the favourable September statistics of production, deliveries and stocks. The "total visible supplies" have fallen by 3,234 tons to 29,892 tons, according to Mr. W. H. Gartsen. The total supplies have shown a decline of about 13,000 tons during the past four months. This rate is, of course, exceptional, but, even so, it will soon be necessary to increase the quota of production, which is at present only 33⅓ per cent. of capacity. The fact that there has not been a substantial increase in price during the past month has been due to the releasing of the heavy stocks held by the Pool.

Daily quotations:—

Cash.—Thursday, £216 15s. to £216 17s. 6d.; Friday, £219 12s. 6d. to £219 15s.; Monday, £222 12s. 6d. to £222 15s.; Tuesday, £221 2s. 6d. to £221 5s.; Wednesday, £221 15s. to £222.

Three Months.— Thursday, £216 10s. to £216 12s. 6d.; Friday, £219 7s. 6d. to £219 10s.; Monday, £222 10s. to £222 12s. 6d.; Tuesday, £221 to £221 5s.; Wednesday, £221 15s. to £221 17s. 6d.

Spelter.—The International Zinc Cartel has now been renewed, as was expected, after some quibbling on the question of the payment of penalties for excess production. In their weekly report, Messrs. Brandeis, Goldschmidt say that this metal has not attracted very much attention, and consequently the price has not varied to any appreciable extent. The galvanising trade is experiencing a rather quiet time, and orders at present are not too plentiful. Nevertheless, inquiry from the trade has been steady, and no doubt will improve as the season advances.

Price fluctuations:—

Ordinary. — Thursday, £16 12s. 6d.; Friday, £16 15s.; Monday, £16 17s. 6d.; Tuesday, £16 13s. 9d.; Wednesday, £16 12s. 6d.

Lead.—After remaining quiet for some time, the market showed more activity towards the end of last week. Trade demand in this country and on the Continent remains quiet, and until there is definite indication of improvement in this respect values are not likely to advance, say Messrs. Rudolf Wolff. The statistical position in the United States showed further improvement, but there is no upward movement.

Daily market prices:—

Soft Foreign (Prompt).—Thursday, £11 18s. 9d.; Friday, £12; Monday, £12 1s. 3d.; Tuesday, £11 18s. 9d.; Wednesday, £11 18s. 9d.

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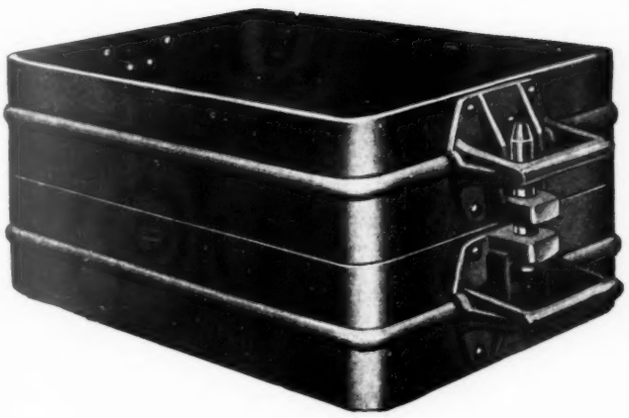

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RAW MATERIALS—PRICE LIST.

(Wednesday, October 4, 1933.)

COPPER.

	£	s.	d.
Standard cash	34	17	6
Three months	35	2	6
Electrolytic	38	5	0
Tough	36	10	0
Best selected	37	0	0
Sheets	64	0	0
India	46	0	0
Wire bars	38	10	0
Ingot bars	38	10	0
H.C. wire rods	40	10	0
Off. av. cash, September	35	3	7 3/4
Do., 3 mths., September	35	7	3 1/2
Do., Sttlmnt., September	35	3	8 1/2
Do., Electro, September	38	13	10 1/2
Do., B.S., September	38	3	7 1/2
Do., wire bars, September	39	0	11 1/2
Solid drawn tubes			10 1/2d.
Brazed tubes			10 1/2d.
Wire			7d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8 3/4d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7 3/4d.
Wire	7 3/4d.
Rolled metal	7 1/2d.
Yellow metal rods	4 3/4d.
Do. 4 × 4 Squares	5 3/4d.
Do. 4 × 3 Sheets	5 3/4d.

TIN.

	£	s.	d.
Standard cash	221	15	0
Three months	221	15	0
English	222	10	0
Bars	223	15	0
Straits	228	15	0
Australian (nom.)	—		
Eastern	227	15	0
Banca	227	15	0
Off. av. cash, September	216	19	3 3/7
Do., 3 mths., September	216	18	4 4/7
Do., Sttlmt., September	216	19	0 4/7

SPELTER.

Ordinary	16	12	6
Remelted	16	5	0
Hard	14	0	0
Electro 99.9	19	0	0
English	17	5	0
India	16	5	0
Zinc dust	20	0	0
Zinc ashes	3	15	0
Off. aver., September	16	18	6 1/7
Aver. spot, September	16	16	2 2/7

LEAD.

Soft foreign ppt.	11	18	9
Empire	12	3	9
English	13	10	0
Off. average, September	12	1	7 3/7
Average spot, September	11	18	7 4/7

ALUMINIUM.

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

Zinc sheets, English	25	15	0
Do., V.M. ex whse.	25	5	0
Rods	30	10	0

ANTIMONY.

English	37	10	0 to	40	0	0
Chinese, ex-whse.				26	10	0
Crude				20	10	0

QUICKSILVER.

Quicksilver	9	5	0 to	9	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	6 10 0
45/50%	12 10 0
75%	19 2 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	5/6 per lb. of Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	2/- lb.
Tungsten metal powder—	
98/99%	2/3 lb.
Ferro-chrome—	
2/4% car.	25 10 0
4/6% car.	21 17 6
6/8% car.	19 7 6
8/10% car.	18 17 6
Ferro-chrome—	
Max. 2% car.	29 15 0
Max. 1% car.	30 17 6
Max. 0.70% car.	35 15 0
70%, carbon-free	10d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel				2	10	0
Bundled steel and shrngs.	1	17	6 to	2	9	0
Mixed iron and steel	2	5	0 to	2	6	6
Heavy cast iron	2	5	0 to	2	7	6
Good machinery				2	7	6
Cleveland—						
Heavy steel				2	5	0
Steel turnings				1	11	6
Cast-iron borings				1	2	0
Heavy forge				2	10	0
W.I. piling scrap				2	0	0
Cast-iron scrap	2	2	6 to	2	5	0
Midlands—						
Light cast-iron scrap	1	18	6 to	2	0	0
Heavy wrought iron				2	10	0
Steel turnings, f.o.r.	1	6	6 to	1	7	6
Scotland—						
Heavy steel				2	5	0
Ordinary cast iron				2	7	6
Engineers' turnings				1	14	0
Cast-iron borings	1	13	6 to	1	15	0
Wrought-iron piling				2	6	3
Heavy machinery	2	10	0 to	2	11	0

London—Merchants' buying prices, delivered yard.

Copper (clean)				29	0	0
Brass				19	10	0
Lead (less usual draft)				10	15	0
Tea lead				8	5	0
Zinc				10	10	0
New aluminium cuttings				72	0	0
Braziery copper				26	0	0
Gunmetal				26	0	0
Hollow pewter				135	0	0
Shaped black pewter				100	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	62/3
,, at Glasgow	65/3
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	60/6
Hematite M/Nos., f.o.t.	60/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	80/-
Clyde, No. 3	80/-
Monkland, No. 3	80/-
Summerlee, No. 3	80/-
Eglinton, No. 3	80/-
Gartsherrie, No. 3	80/-
Shotts, No. 3	80/-

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	6	15	0 to	7	10	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				13	5	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.				8	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅜ in. (Untested)			6 17	6 & up.		
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	10	0 & up.			
Black sheets, 24g. (4-t. lots)				10	5	0
Galv. cor. shts. (,,)				12	15	0
Galv. flat shts. (,,)				13	5	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft	5	5	0 to	5	12	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	15	0 to	5	5	0
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12½d.
Rods	11d.
Tubes	15½d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	18.34
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	13.50
Basic	18.89
Bessemer	19.89
Malleable	19.39
Grey forge	19.39
Ferro-mang. 80%, seaboard	82.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.80
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.10
Plain wire	2.10
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.65

COKE (at ovens).

Welsh foundry	20/- to 22/6
,, furnace	14/- to 15/-
Durham foundry	21/- to 25/-
,, furnace	14/3
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	16/6 to 17/-
,,	28×20 ,,	33/- to 34/-
,,	20×10 ,,	23/9 to 24/3
,,	18¾×14 ,,	17/3 to 17/9
C.W.	20×14 ,,	15/3 to 15/6
,,	28×20 ,,	32/- to 32/6
,,	20×10 ,,	22/6 to 23/-
,,	18⅞×14 ,,	16/3 to 16/9

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	0	0 to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	0	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£30	0	0 to	£31	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Sept.	28 ..	34	11	3	inc.	2/6
„	29 ..	34	17	6	„	6/3
Oct.	2 ..	35	10	0	„	12/6
„	3 ..	35	3	9	dec.	6/3
„	4 ..	34	17	6	„	6/3

Electrolytic Copper.

		£	s.	d.		
Sept.	28 ..	37	15	0	No	change
„	29 ..	38	0	0	inc.	5/-
Oct.	2 ..	38	15	0	„	15/-
„	3 ..	38	10	0	dec.	5/-
„	4 ..	38	5	0	„	5/-

Standard Tin (cash).

		£	s.	d.		
Sept.	28 ..	216	15	0	inc.	2/6
„	29 ..	219	12	6	„	57/6
Oct.	2 ..	222	12	6	„	60/-
„	3 ..	221	2	6	dec.	30/-
„	4 ..	221	15	0	inc.	12/6

Tin (English ingots).

		£	s.	d.		
Sept.	28 ..	217	5	0	inc.	5/-
„	29 ..	220	5	0	„	60/-
Oct.	2 ..	223	5	0	„	60/-
„	3 ..	221	15	0	dec.	30/-
„	4 ..	222	10	0	inc.	15/-

Spelter (ordinary).

		£	s.	d.		
Sept.	28 ..	16	12	6	dec.	1/3
„	29 ..	16	15	0	inc.	2/6
Oct.	2 ..	16	17	6	„	2/6
„	3 ..	16	13	9	dec.	3/9
„	4 ..	16	12	6	„	1/3

Spelter (Electro, 99.9 per cent.).

		£	s.	d.		
Sept.	28 ..	18	7	6	inc.	2/6
„	29 ..	19	0	0	„	2/6
Oct.	2 ..	19	2	6	„	2/6
„	3 ..	19	0	0	dec.	2/6
„	4 ..	19	0	0	No	change

Zinc Sheets (English).

		£	s.	d.		
Sept.	28 ..	25	15	0	No	change
„	29 ..	25	15	0	„	„
Oct.	2 ..	25	15	0	„	„
„	3 ..	25	15	0	„	„
„	4 ..	25	15	0	„	„

Lead (English).

		£	s.	d.		
Sept.	28 ..	13	5	0	No	change
„	29 ..	13	10	0	inc.	5/-
Oct.	2 ..	13	10	0	No	change
„	3 ..	13	10	0	„	„
„	4 ..	13	10	0	„	„

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 7 0	2 7 0	2 6 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 0	2 9 11
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 1' 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6½
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 15 0	3 12 0	3 12 0	3 12 0	3 10 1½	3 9 6	3 14 4½
1931	3 9 6	3 9 6	3 9 6	3 9 6	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 10
1932	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1933	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	—	—	—	—

* No prices available during strike period.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

BRASS Foundry Foreman seeks engagement; last situation 14 years; considerable experience in Government contracts; phosphor-bronze and manganese castings.—Box 496, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

TO Plumbers' Brassfounders. — Engineer, open to travel, invites inquiry to represent you in Lancashire and Cheshire for chromium-plated taps and fittings.—Address, Box 520, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

YOUNG LADY (28), Graduate of Leeds (French and German), seeks post as Foreign Correspondent. Slight knowledge Russian and Spanish. Five years' experience in Steel Works Office. Salary £175, or nearest, with prospects.—Box 510, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN for repetition foundry, near Birmingham. An excellent opening for clever, progressive man.—Apply, Box 516, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager wanted, Birmingham district; repetition work up to half a ton. Excellent opening.—Apply, Box 518, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, an Assistant Foundry Manager with first-class experience of steel and iron casting.—Apply, stating age and particulars of experience, to Box 522, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager wanted, to take charge of malleable foundry; must have good all-round experience with all classes of castings from a few ounces to 1 cwt.; preference given to man with open-hearth melting knowledge.—Apply by letter, stating experience and wages required, to BAYFIELD & BAYFIELD, 95, Colmore Row, Birmingham.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

POSITION required as Foundry Manager or Foreman. Wide experience in Diesel, turbine, marine engines, pumps, hydraulic, machine tools, chemical plant. Modern cupola methods. Excellent testimonials. (227)

POSITION required as Foreman, Assistant Foreman or Assistant to Foundry Manager by young Moulder with sound practical experience, including ferrous and non-ferrous founding. Secondary-school education. Good technical qualifications. Willing to go abroad. (228)

YOUNG Man requires position which will give training and with prospects. Has completed full-time course in foundry practice and had metallurgical and managing experience with well-known foundry. (229)

SITUATIONS VACANT AND WANTED.—*Contd.*

FOREMAN Moulder requires position. Has had complete control of foundries doing general engine and air-compressor work; loam, dry-sand and green-sand experience. Light and heavy work. Competent in cupola control. (230)

PATENT.

THE Proprietor of British Patent No. 353754, relating to "Rotary Furnaces for Smelting Iron and Other Metals," is desirous of securing the full commercial development of the invention in this country either by sale of the Patent outright or by the grant of licences to work thereunder.—Interested parties should communicate in the first instance with ERIC POTTER, Chartered Patent Agent, 3, Staple Inn, London, W.C.1.

PROPERTY.

MAGNIFICENT

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of Shops.

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WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

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